FBISE NOTES

PHYSICS

Faderal Board Islamabad

Presented by:

Urdu Books Whatsapp Group

STUDY GROUP

9TH CLASS

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PHYSICS FOR 9TH CLASS (UNIT # 1)

SHORT QUESTIONS

[Important] What is difference between base quantities and derived quantities? Give three examples in each case.

- Base quantities are the quantities on the basis of which other quantities are expressed. There are 7 physical quantities which form the foundation for other physical quantities. These are called **base quantities**. **For example** Length, Mass, Electric Current, Temperature, Intensity of Light and Amount of Substance.
- The quantities that are expressed in terms of base quantities are called **derived quantities**. **For example** Area, Volume, Speed, Force, Work, Energy, Power, Electric Charge etc.

Pick out the base units from joule, Newton, kilogram, hertz, mole, ampere, meter, Kelvin, coulomb and watt.
Kilogram, mole, ampere, meter, Kelvin are the base units.

Find the base quantities involved in each of the following derived quantities.
Speed:
Unit of Speed is ms^{-1}. So meter and second are base quantities involved in speed.
Volume:
Volume = Length x Width x Height
Volume = m x m x m = m^3
So meter is the base quantity involved in Volume.
Force:
F = ma
Unit of mass is kilogram and unit acceleration is ms^{-2}.
So kilogram, meter and second are base quantities involved.
Work:
W = F x S = ma x S
Unit of mass is kilogram and unit acceleration is ms^{-2} and unit of displacement is meter. So kilogram, meter and second are base quantities are involved.

Suppose your age in seconds.
Suppose my age is 15 years.

Years into Days	=	15 x 365	=	5475
Days into Hours	=	5475 x 24	=	131400
Hours into Min	=	131400 x 60	=	7884000
Min into Sec	=	7884000 x 60	=	473040000 seconds

[Important] What role SI units have played in the development of science?

i) SI system is in use all over the world.
ii) Manipulation in this system is quite easy. i.e. the multiple and sub multiple of different units are obtained simple by multiplying or dividing with ten or powers of ten.

PHYSICS FOR 9TH CLASS (UNIT # 1)

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[Important] What is meant by vernier constant OR Least Count?
The difference between one small division on main scale division and one vernier scale division is 0.1 mm. It is called least count (LC) of the vernier calipers.

[Very Important] What do you understand by the zero error of a measuring instrument?
It is a defect in a measuring device (Vernier Calipers & Screw Gauge) and zero error is caused by an incorrect position of the zero point. For example if zeros of main scale and vernier scale are not in front of each other than zero error will be present.

[Very Important] Why is the use of zero error necessary in a measuring instrument?
As long as you check for zero error, you can then use it to correct your readings. Zero errors are of two types:

- **Positive Zero Error** occurs when zero of vernier scale is on the right side of zero of main scale.
- **Negative Zero Error** occurs when zero of vernier scale is on the left side of zero of main scale.

What is a stop watch?
A stop watch is used to measure the time interval of an event.

Why do we need to measure extremely small interval of times?
We need extremely small interval of time "delta t"(Δt) as the smaller is the time interval better resolution of measurement is possible.

[Very Important] Define significant figures?
All the accurately known digits and the first doubtful digit in an expression are called significant figures. It reflects the precision of a measured value of a physical quantity. Accuracy in measuring a physical quantity depends upon various factors: -

i) The quality of the measuring instrument
ii) The skill of the observer
iii) The number of observations made

[Important] On which factors accuracy of measuring a physical quantity depends?

i) The quality of the measuring instrument
ii) The skill of the observer
iii) The number of observations made

[Important] How is precision related to the significant figures in a measured quantity?
The greater the number of significant figures, the greater the precision. Each significant figures increases the precision by a factor of ten.

ختم نبوت ﷺ زندہ باد

عظمت صحابہ زندہ باد

السلام علیکم ورحمۃ اللہ وبرکاتہ:

معزز ممبران: آپ کا وٹس ایپ گروپ ایڈ من "**اردو بکس**" آپ سے مخاطب ہے۔

آپ تمام ممبران سے گزارش ہے کہ:

- گروپ میں صرف PDF کتب پوسٹ کی جاتی ہیں لہذا کتب کے متعلق اپنے کمنٹس / ریویوز ضرور دیں۔ گروپ میں بغیر ایڈ من کی اجازت کے کسی بھی قسم کی (اسلامی و غیر اسلامی، اخلاقی، تحریری) پوسٹ کرنا سختی سے منع ہے۔
- گروپ میں معزز، پڑھے لکھے، سلجھے ہوئے ممبرز موجود ہیں اخلاقیات کی پابندی کریں اور گروپ رولز کو فالو کریں بصورت دیگر معزز ممبرز کی بہتری کی خاطر ریموو کر دیا جائے گا۔
- کوئی بھی ممبر کسی بھی ممبر کو انباکس میں میسیج، مس کال، کال نہیں کرے گا۔ رپورٹ پر فوری ریموو کر کے کاروائی عمل میں لائے جائے گی۔
- ہمارے کسی بھی گروپ میں سیاسی و فرقہ واریت کی بحث کی قطعاً کوئی گنجائش نہیں ہے۔
- اگر کسی کو بھی گروپ کے متعلق کسی قسم کی شکایت یا تجویز کی صورت میں ایڈ من سے رابطہ کیجئے۔
- سب سے اہم بات:

گروپ میں کسی بھی قادیانی، مرزائی، احمدی، گستاخِ رسول، گستاخِ امہات المؤمنین، گستاخِ صحابہ و خلفائے راشدین حضرت ابو بکر صدیق، حضرت عمر فاروق، حضرت عثمان غنی، حضرت علی المرتضیٰ، حضرت حسنین کریمین رضوان اللہ تعالیٰ اجمعین، گستاخ اہلبیت یا ایسے غیر مسلم جو اسلام اور پاکستان کے خلاف پراپیگنڈا میں مصروف ہیں یا ان کے روحانی و ذہنی سپورٹرز کے لئے کوئی گنجائش نہیں ہے لہذا ایسے اشخاص بالکل بھی گروپ جوائن کرنے کی زحمت نہ کریں۔ معلوم ہونے پر فوراً ریموو کر دیا جائے گا۔

- تمام کتب انٹرنیٹ سے تلاش / ڈاؤنلوڈ کر کے **فری آف کاسٹ** وٹس ایپ گروپ میں شیئر کی جاتی ہیں۔ جو کتاب نہیں ملتی اس کے لئے معذرت کر لی جاتی ہے۔ جس میں محنت بھی صَرف ہوتی ہے لیکن ہمیں آپ سے صرف دعاؤں کی درخواست ہے۔
- عمران سیریز کے شوقین کیلئے علیحدہ سے عمران سیریز گروپ موجود ہے۔
- **لیڈیز کے لئے الگ گروپ کی سہولت موجود ہے جس کے لئے ویریفکیشن ضروری ہے۔**
- اردو کتب / عمران سیریز یا سٹڈی گروپ میں ایڈ ہونے کے لئے ایڈ من سے وٹس ایپ پر بذریعہ میسیج رابطہ کریں اور جواب کا انتظار فرمائیں۔ برائے مہربانی اخلاقیات کا خیال رکھتے ہوئے موبائل پر کال یا ایم ایس کرنے کی کوشش ہر گز نہ کریں۔ ورنہ گروپس سے تو ریموو کیا ہی جائے گا بلاک بھی کیا جائے گا۔

نوٹ: ہمارے کسی گروپ کی کوئی فیس نہیں ہے۔ سب فی سبیل اللہ ہے

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اللہ تبارک تعالیٰ ہم سب کا حامی و ناصر ہو

Define Science.
The knowledge gained through observations and experimentations is called science.

Describe the division of science into two main streams?
Physical Sciences:
They deal with the study of non-living things.
Biological Sciences:
They deal with living things.

[Important] Define the following branches of Physics
Mechanics:
It is the study of motion of objects, its causes and effects.
Heat:
It ceals with the nature of heat, modes of transfer and effects of heat.
Sound:
It deals with the physical aspects of sound waves, their production, properties and applications.
Light (Optics):
It is the study of physical aspects of light, its properties, working and use of optical instruments.
Electricity and Magnetism:
It is the study of the charges at rest and in motion, their effects and their relationship with magnetism.
Atomic Physics:
It is the study of the structure and properties of atoms.
Nuclear Physics:
It ceals with the properties and behavior of nuclei and the particles within the nuclei.
Plasma Physics:
It is the study of production, properties of the ionic state of matter – the fourth state of matter.
Geophysics:
It is the study of the internal structure of the earth.

[Very Important] Describe the Lord Kelvin statement.
When you can measure what you are speaking about the express it in numbers, you know something about it. When you cannot measure what you are speaking about or you cannot express it in numbers, your knowledge is of a meager and of unsatisfactory kind.

[Very Important] What is Andromeda?
Andromeda is one of the billions of galaxies of known universe.

List harmful effects of the scientific inventions on nature?
The scientific inventions have also caused harms and destruction of serious nature. One of which is the environmental pollution and the other is the deadly weapons.

PHYSICS FOR 9TH CLASS (UNIT # 1)

[Very Important] Define Unit.
Once a standard is set for a quantity then it can be expressed in terms of that standard quantity. This standard quantity is called the unit.

[Very Important] List 7 units of System International (SI) along with their symbols and physical quantities.

Qty Name	Qty Symbol	Unit Name	Unit Symbol
Length	l	metre	m
Mass	m	kilogram	kg
Time	t	second	s
Electric Current	I	ampere	A
Intensity of light	L	candela	cd
Temperature	T	Kelvin	K
Amount of Substance	n	mole	mol

[Very Important] What are main advantage of using SI system?
i) SI system is in use all over the world.
ii) Manipulation in this system is quite easy.

[Very Important] Define prefixes.
Prefixes are the words or letters added before SI units such as kilo, mega, giga and mil i etc. Prefixes are useful to express very large or small quantities. Double prefixes are not used. For example no prefix is used with kilogram since it already contains the prefix "kilo".

[Very Important] What is hubble space telescope?
It orbits around the earth. It provides information about stars.

What is a meter rule? What is its least count?
It is an instrument used to measure the length. Its least count is 1 mm or 0.1cm.

What is a measuring tap? What is its least count?
It is an instrument used to measure the length. Its least count is 1 mm or 0.1cm.

What is difference between mechanical and digital vernier caliper?
Digital vernier caliper has greater precision.

What Is beam balance?
It is an ancient (older) instrument to measure the mass of an object.

What is physical balance?
It is an instrument to measure the mass of an object.

What is measuring cylinder?
It is an instrument to measure the volume of a liquid.

LONG QUESTIONS

[Very Important] Write a detailed note on vernier calipers?
Vernier calipers is an **instrument** which is used to **measure** the length correctly upto **1/10th of a millimeter**. So the **least count** of vernier calipers is **0.1mm**.

Structure: -
It consists of **two** parts: -

- One part is called **main scale**. Longer lines represent **centimeter** and small lines represents **millimeters**. On its **left** there is a **jaw A.**
- Second part consists of a **vernier scale**, which contain a **jaw B**. This jaw is **moveable** on main scale. The length of vernier scale is **9mm** which is divided into **10 equal parts**.

(* Draw figure from book)**

Function: -
- Note the **least count** of vernier.
- **Close the jaws A and B**. the zeros of main scale and vernier scale should be **exactly in front** of each other.
- **Fix the sphere** between two jaws and **note the main scale reading**. (The point where the 0 of vernier scale coinciding with main scale division.)
- Now **note the division of vernier scale**, which **exactly** in front of the **any main scale division**. Let the division is **8**.
- Now **multiply 8** with least count **0.01**cm and **add** it to **main scale** reading.
- **Add or subtract** the **zero error** which was faced.
- This is the **diameter** of sphera.

Write a detailed note on screw gauge?
It is an instrument which is used measure the length or diameter correctly upto **1/100th** part of **millimeter**.

Structure: -
- It consists of a **U shaped metal frame** fitted with the **stud A** at one end and an empty **cylinder B** at the other end.
- A **scale in millimeter** is engraved over it parallel to its **axis** along a straight line.
- The cylinder has **threads** inside and **act as a nut.**
- There is **bolt C** inside this nut which **moves** forward or backward on rotating **cylinder B.**

(* Draw figure from book)**

Function: -
- **Note** the **pitch** and **least count** of the screw gauge.
- **Zero** of **circular scale** should be in front of **horizontal line**.
- **Place the sphere** between **stud A and bolt C.**

- Note **main scale reading**.
- Now find the **circular scale division** which in exactly in front of **horizontal line**. Let it is **25**.
- Now **multiply 25** by **least count** and **add** the product in **main scale reading**.
- **Add or subtract** the zero error.
- This is the **diameter** of sphere.

How many types of errors. Describe them?

Personal Errors: -

- These errors arise due to **wrong way of taking reading** e.g. eye is not in front to the scale.
- These errors can be **reduced by experience**.

Random Errors: -

- If different measurements are obtained.
- Then **on repeating the observation readings can differ from the first one**. This type of errors is called random errors.
- These errors can be **reduced by taking the mean** of all the measurement.

Systematic Errors: -

- These errors are **caused due to zero error or wrongly used instruments**.
- To **reduce** these errors **measuring instruments should be compared with standard instrument**.

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PROBLEMS

1.1 Express the following quantities using prefixes.
(a) 5000 g (b) 2000000 W
(c) 52×10^{-10} kg (d) 225×10^{-6} s
{(a) 5 kg (b) 2 MW (c) 5.2 μg (d) 2.25 μs }

Solution:

(a) **5000 g**
= 5 × 1000g
= 5 × 1kg (Since 1000 g = 1 kg)
= 5 kg

(b) **2000,000 W**
= 2 × 1000000
= 2 × 10^6 W
= 2 × Mega W (∵ 10^6 = 1Mega)
= 2 MW

(c) **52×10^{-10} kg**
= 5.2 × 10 × 10^{-10} kg
= 5.2 × 10^{-9} kg
= 5.2 × 10^{-9} × 1000 g (Since 1 kg = 1000 g)
= 5.2 × 10^{-9} × 10^3 g
= 5.2 × 10^{-6} g
= 5.2 μg [∵ 10^{-6} = 1micro(μ)]

(d) **225×10^{-6} s**
= 2.25 × 10^2 × 10^{-6} s
= 2.25 × 10^{-6} s
= 2.25 μs [∵ 10^{-6} = 1micro(μ)]

1.2 How do the prefixes micro, nano and pico relate to each other?

Solution:

As we know
micro = μ = 10^{-6}
nano = n = 10^{-9}
pico = p = 10^{-12}
The relation between micro, nano and pico can be written as.
micro = 10^{-6}
nano = $10^{-6} \times 10^{-3} = 10^{-3}$ micro
pico = $10^{-6} \times 10^{-6} = 10^{-6}$ micro

1.3 Your hair grow at the rate of 1 mm per day. Find their growth rate in nm s^{-1}. (11.57 nm s^{-1})

Solution:

Growth rate of hair in nms^{-1} = 1mm per day
Growth rate of hair in one day = 24 × 60 × 60 s
(Since 1 mm = 10^{-3} m and one day = 24 × 60 × 60 s), hence
1 mm per day = 1×10^{-3} m × $\frac{1}{24\times60\times60}$ s

$= 1 \times 10^{-3}\ m \times \frac{1}{8400}\ ms^{-1}$

$= 1 \times 10^{-3}\ m \times 0.00001157$

$= 1 \times 10^{-3}\ m \times 1157 \times 10^{-8}\ ms^{-1}$

$= 1157 \times 10^{-3}\ m \times 10^{-8} ms^{-1}$

$= 11.57 \times 10^{-9}\ ms^{-1}$

1 mm per day = 11.57 nms^{-1}

(because 10^{-9} ms^{-1} = 1nms^{-1}),

1.4 Rewrite the following in standard form. (Scientific notation)

(a) 1168×10^{-27} (b) 32×10^{4} (c) 725×10^{-6} kg

(d) 0.02×10^{-8}

{(a) 1.168×10^{-24} (b) 3.2×10^{6} (c) 7.25 g (d) 2×10^{-10} }

Solution: (a) $1168 \times 10^{-27} = 1.168 \times 10^{3} \times 10^{-27} = 1.168 \times 10^{-24}$

(b) $32 \times 10^{5} = 3.2 \times 10^{1} \times 10^{5} = 3.2 \times 10^{6}$

(c) 725×10^{-6} kg $= 7.25 \times 10^{2} \times 10^{-6}$ kg $= 7.25 \times 10^{-3}$ kg

As (10^{-3} kg = 1g), therefore

7.25×10^{-3} kg = 7.25 g

(d) $0.02 \times 10^{-8} = 2 \times 10^{-2} \times 10^{-8} = 2 \times 10^{-10}$

1.5 Write the following quantities in standard form.

(a) 6400 km (b) 38000 km

(c) 300000000 ms^{-1} (d) seconds in a day

{(a) 6.4×10^{3} km (b) 3.8×10^{5} km (c) 3×10^{8} m s^{-1} (d) 8.64×10^{4} s}

Solution: (a) 64000 km

Multiplying and dividing by "10^{3}"

$= \frac{6400\ m}{1000} \times 10^{3}$km

$= \frac{64\ m}{10} \times 10^{3}$km

$= 6.4 \times 10^{3}$km

(b) 38000 km

Multiplying and dividing by "10^{5}"

$= \frac{38000}{10^{5}} \times 10^{5}$km

$= \frac{380000}{10^{50000}} \times 10^{5}$km

$\simeq 3.8 \times 10^{5}$km

(c) 300000000 ms^{-1}

Multiplying and dividing by "10^{8}"

$= \frac{300000000\ ms^{-1}}{100000000} \times 10^{8}$km

$= 3 \times 10^{8}$km

(d) seconds in a day

As we know

1 day = 24 hours

1 hour = 60 minutes

1 minute = 60 seconds So

1 day = 24 × 60 × 60 seconds

1 day = 86400 s

1 day = 86400 s

Multiplying and dividing by 10^4

$= \frac{864 \times 10^4}{1 \times 10^4}$ s

$= 10^4$ s

1.6 On closing the jaws of a Vernier Callipers, zero of the vernier scale is on the right to its main scale such that 4th division of its vernier scale coincides with one of the main scale division. Find its zero error and zero correction. (+0.04 cm, -0.04 cm)

Solution:

Main scale reading = 0.0 cm

Vernier division coinciding with main scale = 4th division

Vernier scale reading = 4 × 0.01 cm = 0.04 cm

Zero error = 0.0 cm + 0.04 cm = 0.04 cm

Zero correction (ZC) = -0.04 cm

The zero of the vernier scale is 0.04cm and its zero correction is -0.04cm

(vernier division coinciding with main scale) = 4 div

Vernier scale reading = 4 × 0.01 cm

= 0.04 cm

As the zero of the vernier scale is on the right side of the zero of the main scale, thus instrument has measured more than the actual reading. It is called the positive zero error.

Zero correction is the negative of zero error. Thus

Zero error = +0.04 cm

and Zero correction = -0.04 cm

1.7 A screw gauge has 50 divisions on its circular scale. The pitch of the screw gauge is 0.5 mm. What is its least count? (0.001 cm)

Solution:

Number of divisions on the circular scale = 50

Pitch = 0.5 mm

Least count of screw gauge L.C. = ?

$$\text{Least count} = \frac{\text{Pitch}}{\text{Number of divisions on circular scale}}$$

$$\text{Least count} = \frac{0.5\text{ mm}}{50}$$

$$= 0.01\text{ mm} = 0.01 \times \frac{1}{10}\text{ cm}$$

Least count = 0.001 cm

1.8 Which of the following quantities have three significant figures?

(a) 3.0066 m (b) 0.00309 kg

(c) 5.05×10^{27} kg (d) 301.0 s

{(b) and (c)}

Solution:

(a) 3.0066m

Zeros between significant digits are significant. Therefore, there are 5 significant figures in 3.0066 m.

(b) 0.00309kg

Zeros used for spacing the decimal point are not significant. Therefore there are 3 significant figures in 0.00309kg.

(c) 5.05×10^{-27}kg

Only the digits before the exponent are considered, thus there are 3 significant figures.

(d) 301.0s

Final zeros or zeros after the decimal are significant. Therefore, there are 4 significant figures.

Result:

Quantities (b) and (c) have three significant figures.

1.9 What are the significant figures in the following measurements?

(a) 1.009 m **(b) 0.00450 kg**

(c) 1.66×10^{-27} kg **(d) 2001 s**

{(a) 4 (b) 3 (c) 3 (d) 4}

Solution:

(a) 1.009m

Since zeros between two significant figures are significant, so there are 4 significant figures

(b) 0.00450

Zeros used for spacing the decimal point are not significant. There are 3 significant figures.

(c) 1.66×10^{-27}

Only the digits before the exponent are considered, so there are 3 significant figures

(d) 2001s

Since zeros between two significant figures are significant, there are 4 significant figures

1.10 A chocolate wrapper is 6.7 cm long and 5.4 cm wide. Calculate its area up to reasonable number of significant figures. (36 cm^2)

Solution:

Length of chocolate wrapper l = 6.7 cm

Width of chocolate wrapper w = 5.4 cm

Area = A = ?

Area = Length × Width

● $A = l \times w$

$A = 6.7cm \times 5.4\ cm = 36.18\ cm^2 = 36cm^2$

Note:

Answer should be in two significant figures because in data the significant figures are two therefore answer is 36 cm^2.

PHYSICS FOR 9TH CLASS (UNIT # 2)

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SHORT QUESTIONS

[Important] Question: Differentiate between followings:

Rest and Motion:

- A body is said to be at **rest**, if it does not change its position with respect to its surroundings.
- A body is said to be in **motion**, if it changes its position with respect to its surroundings.

Circular Motion and Rotatory Motion:

- Any turning as if on an axis is rotatory motion.
- Any rotatory motion where the radius of gyration length and axis of rotation are fixed is circular motion.
- So the main difference is that there is no fixed axis and radius restriction for rotatory motion, but there is for circular motion.

Scalars and Vectors:

- A **scalar** quantity is described completely by its magnitude only. For example mass, length, time, speed, volume, work, energy, density, power, electric charge, pressure, area, temperature etc.
- A **vector** quantity is described completely by magnitude and direction. For example velocity, displacement, force, momentum, torque, weight, electric potential etc.

Distance and Displacement:

Distance	**Displacement**
• Length of a path between two points is called the distance between those points. • Distance is a scalar quantity • Distance is denoted by "S" and S = vt. • Its unit is metre (m)	• Displacement is the shortest distance between two points which has magnitude and direction. • Displacement is a vector quantity. • Displace is denoted by "d" and d = vt • Its unit is metre (m)

Speed and Velocity:

Speed	**Velocity**
The distance covered an object in unit time is called its speed	The rate of displacement of a body is called its velocity.
$\text{Speed} = \frac{\text{Distance covered}}{\text{Time taken}}$	$\text{Velocity} = \frac{\text{Displacement}}{\text{Time taken}}$
Distance = speed x time S = vt	v = d / t d = vt
Speed is scalar quantity	Velocity is vector quantity
Its SI unit is meter per second (ms^{-1})	Its SI unit is meter per second (ms^{-1})

Linear Motion and Random Motion:

- Straight line motion of a body is known as linear motion. For example a car is moving on straight and level road or aero plane flying straight in air.
- The disordered or irregular motion of an object is called random motion. For example motion of insects and birds.

[Very Important] Question: What is Gyration Length?

A length that represents the distance in a rotating system between the point about which it is rotating and the point to or from which a transfer of energy has the maximum effect.

Question: Define Acceleration:

Acceleration is defined as the rate of change of velocity of a body.

$$\text{Acceleration} = \frac{\text{Change in velocity}}{\text{Time taken}}$$

$$a = \frac{V_f - V_i}{t}$$

The SI unit of acceleration is meter per second per second (ms^{-2})

[Important] Question: Can a body moving at a constant speed have acceleration?

Yes, when a body is moving with constant speed, the body can have acceleration if its direction changes. For example if the body is moving along a circle with constant speed. It will have acceleration due to the change of direction at very instant.

[Important] Question: How do riders in a Ferris wheel possess translatory motion but not circular motion?

Riders in a Ferris wheel possess translatory motion because their motion is in a circle without rotation.

Question: How can vector quantities be represented graphically?

To differentiate a vector from a scalar quantity, we generally se bold letters to represent vector quantities, such as F, a, d or a bar or arrow over their symbols such as $\bar{F}$, $\bar{a}$, $\bar{d}$ or $\vec{F}$.

Graphical representation:

A straight line is drawn with an arrow head at one end. The length of the line, according to some suitable scale, represents the magnitude and the arrow head gives the direction of the vector.

[Important] Question: Why vector quantities cannot be added and subtracted like scalar quantities?

The scalar quantities obey the rules of arithmetic and ordinary algebra because scalar quantities have no direction. Since vectors have magnitude as well as direction, so vectors obey the special rules of vector algebra therefore vectors are added by head to tail rule. (Vector Algebra)

Question: Which from following can be obtained from speed-time graph. Initial Speed, Final Speed, Distance covered in time and Acceleration of motion.

All above factors can be obtained from speed-time graph.

>> Question: Define Kinematics.

It is the study of motion of an object without discussing the cause of motion.

>> Question: Define Surroundings.

Surroundings are the places in its neighborhood where various objects are present.

PHYSICS FOR 9TH CLASS (UNIT # 2)

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[Important] >> Question: List types of motion

i) Translatory motion (Linear, Random and Circular)
ii) Rotatory motion
iii) Vibratory motion

[Very Important] >> Question: Define Translatory motion and its types.

In translatory motion, body moves along a line without any rotation. The line may be straight or curved. It has following types:

Linear Motion:

Straight line motion of a body is called linear motion. For example car moving in straight line.

Circular Motion:

The motion of an object in a circular path is called circular motion. For example a stone tied at one end of string and whirled.

Random Motion:

The disordered or irregular motion is called random motion. For example motion of birds and insects.

[Important] >> Question: Define Rotatory Motion.

The spinning motion of a body about its axis is called rotary motion. For example the top spins about its axis passing through it and thus it possess rotatory motion.

[Important] >> Question: Define Vibratory motion.

To and fro motion of a body about its mean position is called vibratory motion. For example motion of a baby in swing.

>> Question: Mention type of motion in followings.

A ball moving vertically upward	Linear motion
A child moving down a slide	Linear motion
Movement of a player in a football ground	Random motion
The flight of a butterfly	Random motion
An athlete running in a circular track	Circular motion
The motion of a wheel	Circular motion
The motion of a cradle	Vibratory motion

[Important] >> Question: Define Position.

The term position describes the location of a place or a point with respect to some reference point called origin.

>> Question: Which is fastest animal on the earth?

Falcon can fly at a speed of 200 kmh^{-1}. While Cheetah can run at a speed of 70kmh^{-1}

[Very Important] >> Question: What is LIDAR gun?

A LIDAR gun is light detection and ranging speed gun. It uses the time taken by laser pulse to make a series of measurements of a vehicle's distance from the gun. The data is then used to calculate the vehicle's speed.

[Very Important] >> Question: Define Uniform, Variable and Average Speed.

- A body has **uniform speed** if it covered equal distances in equal intervals of time however short the interval may be.
- If a body covers unequal distances in equal interval of time, however small the intervals may be, the speed of the body is said to be **variable**.
- The ratio between distance and total time taken is known as **average speed**.

[Very Important] >> Question: Define Uniform Velocity, Variable Velocity and Average Velocity?

- A body has **uniform velocity** if it covers equal displacement in equal intervals of time however short the interval may be.
- If speed or direction changes with time then the velocity is said to be **variable.**
- The ratio between displacement and time is known as **average velocity**.

[Very Important] >> Question: Define Uniform Acceleration, Variable Acceleration and Positive & Negative Acceleration.

- A body has **uniform acceleration** if it has equal changes in velocity in equal intervals of time however short the interval may be.
- A body has **variable acceleration** if it has not equal changes in velocity in equal intervals of time however short the interval may be.
- Acceleration of a body is **positive** when its velocity is increasing and **negative** when its velocity is decreasing.

[Important] >> Question: Define Graph, Variables, Independent quantity and dependent quantity.

- **Graph** is a pictorial way of presenting information about the relation between various quantities.
- The quantities between which a graph is plotted are called **variables**.
- One of the quantities is called **independent quantity**.
- The value of which varies with the independent quantity is called the **dependent quantity.**

>> Question: What is the purpose of distance time graph?

It is useful to represent the motion of objects using graphs.

>> Question: Define Gravitational Acceleration.

The acceleration of freely falling bodies is called gravitational acceleration. It is denoted by g. Its value is approximately $10ms^{-2}$.

[Very Important] >> Write equation of motion under gravity.

i) $V_f = V_i + gt$ ii) $h = V_it + \frac{1}{2} gt^2$ iii) $2gh = V_f^2 - V_i^2$

LONG QUESTIONS

[Very Important] >> Question: Derive the First Equation of Motion?

Let a car is moving with initial velocity (v_i). After time (t) its velocity becomes (v_f). As the car is moving with uniform acceleration therefore its acceleration (a) will be equal to the average acceleration (a_{av}):

$$a = \frac{\text{Change in Velocity}}{\text{Total Time}}$$

$$a = \frac{V_f - V_i}{t}$$

$$at = V_f - V_i$$

$at + V_i = V_f$

OR

$V_f = V_i + at$

Second Method:

Speed-time graph for the motion of a body is shown in figure. Slope of line AB gives the acceleration a of a body.

slope of line AB = $a = \frac{AB}{Ac} = \frac{BD - CD}{OD}$

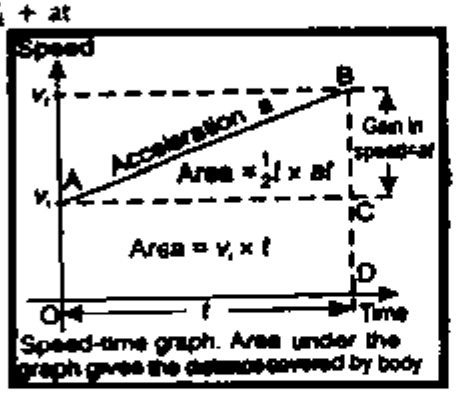
as

$BD = V_f$, $CD = V_i$ and $OD = t$

Hence $a = \frac{V_f - V_i}{t}$

or $V_f - V_i = at$

$V_f = V_i + at$



Speed-time graph. Area under the graph gives the distance covered by body

[Very Important] >> Question: Derive the Second Equation of Motion?

A body is moving with initial velocity (V_i) and after time (t) its velocity becomes (V_f). Then to calculate the total distance (S) covered in time (t):

Distance = Average Velocity x Time

$S = V_{av} \times t$ ---------- (i)

We know that

$$V_{av} = \frac{V_i + V_f}{2}$$

So, Putting this value in equation (i)

$$S = \frac{V_i + V_f}{2} \times t$$

And we know that $V_f = V_i + at$

So,

$$S = \frac{V_i + V_i + at}{2} \times t$$

$$S = \frac{2V_i + at}{2} \times t$$

$$S = \frac{2V_it + at^2}{2}$$

$$S = \frac{2V_it}{2} + \frac{at^2}{2}$$

$$S = V_it + \frac{1}{2}at^2$$

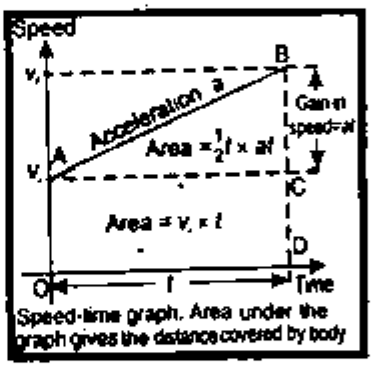
Second Method:

In speed-time graph shown in figure, the total distance S travelled by the body is equal to the total area OABD under the graph. That is

Total distance S = area of (rectangle OACD + triangle ABC)

Area of rectangle OACD $= OA \times OD$
$= V_i \times t$

Area of triangle ABC $= \frac{1}{2}(AC \times BC)$
$= \frac{1}{2}t \times at$



Speed-time graph. Area under the graph gives the distance covered by body

Since Total area OABD = area of rectangle OACD + area of triangle ABC

Putting values in the above equation, we get

$$S = V_it + \frac{1}{2}t \times at$$

$$S = V_it + \frac{1}{2}at^2$$

[Very Important] >> Question: Derive the Third Equation of Motion?

A body is moving with initial velocity (v_i) and after time (t) its velocity becomes (v_f) then distance covered by it is given by:

$$S = \frac{(V_i + V_f)}{2} \times t \quad \text{---------- (i)}$$

We know that

$$V_f = V_i + at$$

OR

$$t = \frac{V_f - V_i}{a}$$

Putting the value of t in equation (i)

$$S = \frac{(V_i + V_f)}{2} \times \frac{(V_f - V_i)}{a}$$

$$2aS = (V_i + V_f) \times (V_f - V_i)$$

$$2as = V_f^2 - V_i^2$$

Second Method:

In speed-time graph shown in figure, the total distance S travelled by the body is given by the total area OABD under the graph.

Total area OABD = $S = \frac{OA + BD}{2} \times OD$

or $2S = (OA + BD) \times OD$

Multiply both sides by $\frac{BC}{OD}$, we get: $\left(\because \frac{BC}{OD} = a\right)$

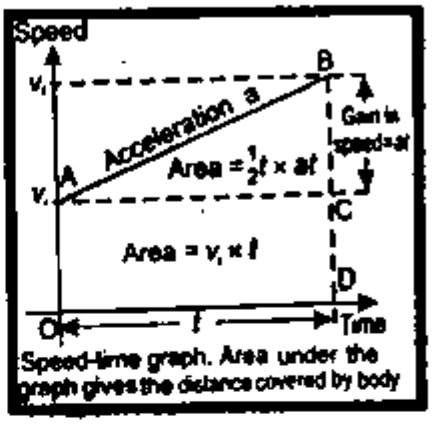
$2S \times \frac{BC}{OD} = (OA + BD) \times OD \times \frac{BC}{OD}$

$2S \times \frac{BC}{OD} = (OA + BD) \times BC$ .... (i)

Putting the values in the above equation (i), we get

$2S \times a = (V_i + V_f) \times (V_f - V_i)$

$2as = V_f^2 - V_i^2$



Speed-time graph. Area under the graph gives the distance covered by body

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PROBLEMS

2.1 A train moves with a uniform velocity of 36 kmh^{-1} for 10 s. Find the distance travelled by it. (100 m)

Solution: Velocity = v = 36kmh^{-1} = $\frac{36 \times 1000}{60 \times 60}$ = $\frac{36000}{3600}$ = 10ms^{-1}

Time t = 10s

Distance = S = ?

S = vt

S = 10 × 10 = 100m

2.2 A train starts from rest. It moves through 1 km in 100 s with uniform acceleration. What will be its speed at the end of 100 s. (20 ms^{-1})

Solution: Initial velocity v_i = 0 ms^{-1}

Distance S = 1km = 1000 m

Time t = 100 s

Final velocity v_f = ?

$S = v_i t + \frac{1}{2} at^2$

$1000 = 0 \times 100 + \frac{1}{2} \times a \times (100)^2$

$1000 = \frac{1}{2} \times 10000a$

$1000 = 5000a$

$a = \frac{1000}{5000} = 0.2\ ms^{-2}$

Now using 1st equation of motion

$v_f = v_i + at$

$v_f = 0 + 0.2 \times 100$

$v_f = 20\ ms^{-1}$

2.3 A car has a velocity of 10 ms^{-1}. It accelerates at 0.2 ms^{-2} for half minute. Find the distance travelled during this time and the final velocity of the car. (390 m, 16 ms^{-1})

Solution: Initial velocity = $v_i = 10ms^{-1}$

Acceleration $a = 0.2ms^{-2}$

Time $t = 0.5min. = 0.5 \times 60 = 30\ s$

(i) Distance S = ?

(ii) Final velocity v_f = ?

$S = vit + \frac{1}{2} at^2$

$S = 10 \times 30 + \frac{1}{2} \times 0.2 \times (30)^2$

$S = 300 + \frac{1}{2} \times \frac{2}{10} \times 900$

$S = 300 + 90$

$S = 390\ m$

(ii) Using 1st equation of motion

$v_f = v_i + at$

$v_f = 10 + 0.2 \times 30$

$v_f = 10 + 6$

$v_f = 16\ ms^{-1}$

2.4 A tennis ball is hit vertically upward with a velocity of 30 ms^{-1}. It takes 3 s to reach the highest point. Calculate the maximum height reached by the ball. How long it will take to return to ground? (45 m, 6 s)

Solution: Initial velocity = $v_i = 30\ ms^{-1}$

Acceleration due to gravity $g = -10\ ms^{-2}$

Time to reach maximum height = t = 3 s

Final velocity = $v_f = 0\ ms^{-1}$

(i) Maximum height attained by the ball S = ?

(ii) Time taken to return to ground t = ?

$S = vit + \frac{1}{2} gt^2$

$S = 30 \times 3 + \frac{1}{2} \times (-10) \times (3)^2$

$= 90 - \frac{1}{2} \times 10 \times 9$

$= 90 - 45$

$S = 45m$

Total time = Time to reach maximum height + Time to return to the ground

$= 3s + 3s = 6s$

2.5 **A car moves with uniform velocity of 40 ms^{-1} for 5 s. It comes to rest in the next 10 s with uniform deceleration. Find (i) deceleration (ii) total distance travelled by the car** **($-4\ ms^{-2}$, 400 m)**

Solution: Initial velocity = $v = 40\ ms^{-1}$
Time = $t = 5s$
Final velocity = $v_f = 0\ ms^{-1}$
Time $t = 10s$

(i) Deceleration $a = ?$

(ii) Total distance $S = ?$

$v_f = v + at$

or $at = v_f - v_i$

$a = \frac{0 - 40\ ms^{-1}}{10s}$

$a = -4ms^{-2}$

(ii) Total distance travelled = $S = S_1 + S_2$

By using the relation

$S_1 = vt$

$S_1 = 40 \times 5$

$S_1 = 200\ m$ ..... i)

Now by using 3rd equation of motion

$2aS = v_f^2 - v_i^2$

or $S_2 = \frac{v_f^2 - v_i^2}{2a}$

$S_2 = \frac{(0)^2 - (40)^2}{2 \times (-4)}$

$S_2 = \frac{-1600}{-9}$

$S_2 = 200\ m$ ..... (ii)

From (i) and (ii) we get:

$S = S_1 + S_2$

or $S = 200m + 200m$

$S = 400m$

2.6 **A train starts from rest with an acceleration of 0.5 ms^{-2}. Find its speed in kmh^{-1}, when it has moved through 100 m. (36 kmh^{-1})**

Solution: Initial velocity $v_i = 0\ ms^{-1}$
Acceleration $a = 0.5\ ms^{-2}$
Distance $S = 100\ m$
Final velocity $v_f = ?$
$2aS = v_f^2 - v_i^2$
$2 \times 0.5 \times 100 = v_f^2 - 0$
or $100 = v_f^2$
or $v_f^2 = 100$
$v_f = 10ms^{-1}$ ..... (i)

Speed in kmh^{-1}:
From (i) we get

$$V_f = \frac{10 \times 3600}{1000} = 36\ kmh^{-1}$$

2.7 A train staring from rest, accelerates uniformly and attains a velocity 48 kmh^{-1} in 2 minutes. It travels at this speed for 5 minutes. Finally, it moves with uniform retardation and is stopped after 3 minutes. Find the total distance travelled by the train. (6000 m)

Solution: Case-I:

Initial velocity = $v_i = 0$ ms^{-1}

Time = t = 2 minutes = $2 \times 60 = 120\ s$

Final velocity = $v_f = 48$ kmh$^{-1} = \frac{48 \times 1000}{3600} = 13.33$ ms^{-1}

$S_1 = v_{av} \times t$ .....(i)

$S_1 = (\frac{v_f + v_i}{2}) \times t$

$S_1 = \frac{13.333 + 0}{2} \times 120$

$S_1 = 6.6665 \times 120$

$S_1 = 799.99$ m ≈ 800 m

Case-II:

Uniform velocity = $v_f = 13.333$ ms^{-1}

Time = t = 5 minutes $5 \times 60 = 300\ s$

$S_2 = v \times t$

$S_2 = 13.333 \times 300$

$S_2 = 3999.9$ m $= 4000$ m

Case-III:

Initial velocity = $v_i = 13.333$ ms^{-1}

Final velocity = $v_f = 0$ ms^{-1}

Time = t = 3 minutes = $3 \times 60 = 180$ s

$S_3 = v_{av} \times t$ ....(ii)

$S_3 = (\frac{v_f + v_i}{2}) \times t$

$S_3 = (\frac{0 + 13.333}{2}) \times 180$

$S_3 = 6.6665 \times 180$

$S_3 = 1199.97$ m ≈ 1200 m

Total distance = $S = S_1 + S_2 + S_3$

$S = 800 + 4000 + 1200$

$S = 6000$ m

2.8 A cricket ball is hit vertically upwards and returns to ground 6 s later. Calculate

(i) maximum height reached by the ball,

(ii) initial velocity of the ball. (45 m, 30 ms^{-1})

Solution: Acceleration due to gravity = $g = -10$ ms^{-2} (for upward motion)

Time to reach maximum height (one sided time) = $t = \frac{6}{2} = 3$ s

Velocity at maximum height = $v_f = 0$ ms^{-1}

(i) Maximum height reached by the ball $S = h = ?$

(ii) Maximum initial velocity of the ball $v_i = ?$

Since, $v_f = vi + gt$

$0 = v_i - (-10) \times 3$

$v_i = 30$ ms^{-1}

(ii) Now using 3rd equation of motion

$2aS = v_f^2 - v_i^2$

$S = \frac{v_f^2 - v_i^2}{2a}$

$S = \frac{(0)^2 - (10)^2}{2 \times (-10)}$

$S = \frac{100}{20}$

$S = 45\ m$

2.9 When brakes are applied, the speed of a train decreases from 96 kmh^{-1} to 48 kmh^{-1} in 800 m. How much further will the train move before coming to rest? (Assuming the retardation to be constant). **(266.66 m)**

Solution: Initial velocity = $v_i = 96\ kmh^{-1} = \frac{96 \times 1000}{60 \times 60} = \frac{96000}{3600}\ ms^{-1}$

Final velocity = $v_f = 48\ kmh^{-1} = \frac{48 \times 1000}{60 \times 60} = \frac{48000}{3600}\ ms^{-1}$

Distance = S = 800 m

Further Distance = S_1 = ?

First of all we will find the value of *acceleration a*

$2aS = v_f^2 - v_i^2$

$2 \times a \times 800 = \left(\frac{48000}{3600}\right)^2 - \left(\frac{96000}{3600}\right)^2$

$1600a = \left(\frac{48000}{3600}\right)^2 - \left(\frac{2 \times 48000}{3600}\right)^2$ ($\because 96000 = 2 \times 48000$)

$1600a = \left(\frac{48000}{3600}\right)^2 \{(1)^2 - (2)^2\}$ (*Taking* $\left(\frac{48000}{3600}\right)^2$ *as a common*)

$1600a = \left(\frac{48000}{3600}\right)^2 \{1 - 4\}$

$1600a = \left(\frac{48000}{3600}\right)^2 \{-3\}$

$a = -\left(\frac{48000}{3600}\right)^2 \times \frac{3}{1600}\ ms^{-2}$

Now, we will find the value of further distance S_1:

$v_f = 0$ $S_1 = ?$

$2aS = v_f^2 - v_i^2$

$-2\left(\frac{48000}{3600}\right)^2 \times \frac{3}{1600} \times S_1 = (0)^2 - \left(\frac{48000}{3600}\right)^2$

$S_1 = \left(\frac{48000}{3600}\right)^2 \times \left(\frac{3600}{48000}\right)^2 \times \frac{1600}{3 \times 2}$

$S_1 = \frac{1600}{6}$

$S_1 = 266.66\ m$

2.10 In the above problem, find the time taken by the train to stop after the application of brakes. **(80 s)**

Solution: By taking data from problem 2.9:

Initial velocity = $v_i = 96\ kmh^{-1} = \frac{96 \times 1000}{60 \times 60} = \frac{96000}{3600}\ ms^{-1}$

Final velocity = $v_f = 0$

$a = -\left(\frac{48000}{3600}\right)^2 \times \frac{3}{1600}\ ms^{-2}$

Time = t = ?

$v_f = v_i + at$

or $at = v_f - v$

or $t = \frac{v_f - v_i}{a}$

$t = \frac{0 - \frac{48000}{3600}}{-\left(\frac{48000}{3600}\right)^2 \times \frac{3}{1600}}$

$t = -\frac{48000}{3600} \times -\left(\frac{3600}{48000}\right)^2 \times \frac{1600}{3}$

$t = \frac{2 \times 48000}{3600} \times \left(\frac{3600}{48000} \times \frac{3600}{48000}\right) \times \frac{1600}{3}$

$t = \frac{2 \times 3600 \times 1600}{48000 \times 3}$

$t = \frac{2 \times 3600}{3 \times 3}$

$t = 2 \times 40 = 80\ s$

PHYSICS FOR 9TH CLASS (UNIT # 3)

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SHORT QUESTIONS

Question: Define followings:

Inertia:

Inertia of a body is its property due to which it resists any change in its state of rest or motion

Momentum:

Momentum of a body is the quantity of motion it possesses due to its mass and velocity. The momentum P of a body is given by the product of its mass m and velocity v. Thus

$P = mv$

It is vector quantity. Its SI unit is $kgms^{-1}$.

Force:

A force moves or tends to move, stops or tends to stop the motion of a body. The force can also change the direction of motion of a body.

$F = ma$

SI unit for force is Newton.

Force of friction:

The force that opposes the motion of moving objects is called friction

Centripetal Force:

Centripetal force is a force that keeps a body to move in a circle. In other words, the center seeking force is called the centripetal force. It always acts perpendicular to the motion of the body.

$$F_c = \frac{mv^2}{r}$$

Question: Differentiate between followings:

Mass and Weight:

Mass	Weight
• The quantity of matter contained in a body is called its mass.	• Weight is the force with which earth attracts a body towards its center.
• It remains constant everywhere.	• It changes its value everywhere.
• It is scalar quantity.	• It is vector quantity
• Its unit is kilogram.	• Its unit is Newton.
• It can never be zero.	• It can be zero.

Action and Reaction:

Let a body A exerts a force on another body B, the body B reacts against this force and exerts a force on body A. The force exerted by body A on B is the **action force** whereas the force exerted by body B on A is called the **reaction force**.

Sliding Friction and Rolling Friction:

- A force between the sliding objects which opposes the relative motion between them is called **sliding friction**.
- **Rolling friction** is a force of friction between a rolling body and a surface over which it rolls. It is lesser than sliding friction.

>> Question: Why is it dangerous to travel on the roof of a bus?

Because in this case the friction force due to air is acting on the upper part of body and lower portion remain at rest w.r.t the roof due to inertia. Friction force try to turn over which is dangerous for passenger.

>> Question: Why does a passenger move outward when a bus takes a turn?

- An inward net force is required to make a turn in a circle. This required force is known as a centripetal force. In the absence of any net force, an object in motion (such as the passenger) continues in motion in a straight line at constant speed.
- So, due to the absence of necessary centripetal force a passenger moves outward when a bus takes a turn.

>> Question: What will be the tension in a rope that is pulled from its end by two opposite forces 100 N each?

Tension in the rope and its force pulls equally at both the ends. If no forces are acting on the rope except its ends, and the rope itself being in equilibrium, then the tension is the same throughout the rope.

>> Question: Action and reaction are always equal and opposite. Then how does a body moves?

- Actions and reactions are equal and opposite when the object is at equilibrium.
- When we apply external force to pull, push and twist, the equilibrium is disturbed means, now the magnitude of action (force provided by you) and reaction (force provided by the objects) is not equal.
- That is why it is possible to twist, pull, move and push the object in the direction of applied force.

>> Question: A horse pushes the cart. If the action and reaction are equal and opposite then how does the cart move?

- First of all when the horse pulls on the cart, the cart exerts and equal but opposite reaction on the horse. If this was the only force in action then the horse and cart would indeed remain stationary.
- However there is another force between the horse and the ground, the horse's hooves press down on the ground and the ground pushes back on the horse.
- If the reaction force of the ground is greater than the reaction force of the cart on the horse, then the horse will move forward.
- The cart will move forward when the force exerted on it by the hose is greater than the frictional force between the cart and the ground.

>> Question: Define the law of conservation of momentum. What is its importance?

This law states that the momentum of an isolated system of two or more than two interacting bodies remains constant. This Law of conservation of momentum is applicable on all objects in the universe. A rocket and jet engine taking off, the recoil of a gun, and a bank-shot in a pool are examples which demonstrate the importance of law of conservation of momentum.

>> Question: Why is the law of conservation of momentum important?

Law of conservation of momentum is applicable on all objects in the universe. A rocket and jet engine taking off, the recoil of a gun and a bank shot in a pool are examples which demonstrate the importance of law of conservation of momentum.

>> Question: When a gun is fired, it recoils. Why?

Before firing the gun, both the gun and bullet are at rest, so the total momentum of the system is zero. As the gun is fired, bullet shoots out of the gun and acquires momentum. To conserve momentum of the system, the gun recoils.

>> Question: Describe two situations in which force of friction is needed.

i) Friction is needed to walk on the ground.
ii) To stop a bicycle, rubbers pads provide friction against the rims which stops the bicycle.

>> Question: How does oiling the moving parts of a machine lowers friction?

The friction can be reduced by lubricating the sliding surfaces. The oil helps slick (polished) the two surfaces so that the molecular surfaces become easier to slide on with less friction.

>> Question: Describe ways to reduce friction?

- Friction can be reduced by making the sliding surfaces smooth.
- Friction can be reduced by making fast moving objects a streamline shape (fish shape) such as cars, aeroplanes etc. This minimize the air resistance.
- Friction can be reduced by lubricating the sliding surfaces.
- Friction can be reduced by using ball bearings or roller bearings because rolling friction is much less than sliding friction.

>> Question: Why rolling friction is less than sliding friction?

- Rolling friction is the force of friction between a rolling body and a surface over which it rolls. Rolling friction is lesser than the sliding friction.
- But when a body moves over surface of another body, there is relative motion between the two surfaces, thus friction has some maximum value.

>> Question: What do you know about the followings?

Tension in a string: -

The force exerted by a string when it is subjected to pull is called tension in the string. In SI system, its unit is Newton.

Limiting force of friction:

The maximum value of friction is known as the force of limiting friction (Fs). It depends on the normal reaction (pressing force) between the two surfaces in contact.

Braking Force:

Friction between a rotating component (drum or disk) and a stationary component (the brake shoe or pad) causes the drum or disc to slow down such a force is called braking force.

There are four main aspects which determine the amount of braking force: -

- The diameter of disc
- The friction material
- The size of the pad friction face
- The force used to clamp the pads onto the disc.

Skidding of vehicles:

Skidding occurs when:

- Clutch is suddenly engagec
- Brakes are applied too hard
- Vehicle accelerates too quickly
- Steering wheel is turned too sharply

If the brakes are applied too hard, the wheels of the car will lock up and the car will skid due to its large momentum.

Seatbelts:

Without seatbelts, in case of accidents, a person will continue moving until stopped suddenly by something. Seatbelts are useful in two ways:

- They provide external force to person.
- The additional time required for stretching seat belts. Th s prolongs the stopping time for momentum to change is and reduces the effect of collusion.

Banking of Roads:

- The curvature of the road must be inclined so as to control the centrifugal force of the vehicle.
- It is helpful because if the velocity of car is more cr there is less friction between the tyres and road which reduce the danger of car to move out of circular track.

Cream Separator:

- It is high speed spinner. It acts on the principle of centrifuge machines.
- The bowl spins at very high speed causing the heavier contents of milk to move outward in the bowl pushing the lighter contents inward towards the spinning axis.

>> Question: What would happen if all friction suddenly disappears?

If there was no friction then we could not walk, we would keep slipping nothing would be steady on the ground, many things would be just sliding and sliding.

>> Question: Why the spinner of a washing machine is made to spin at a very high speed?

- They dryer of a washing machine is basket spinners.
- They have a perforated wall having large numbers of fine holes in the cylindrical rotor.
- The lid of the cylindrical container is closed after putting wet clothes in it.
- When it spins at high speed, the water from wet clothes is forced out through these holes due to lack of centripetal force.

>> Question: Define dynamics.

The branch of mechanics that deals with the study of motion of an object and the cause of its motion is called dynamics.

>> Question: **Put one rupee coin over a piece of card paper placed on an empty glass. Push the card with a sudden stroke of finger. Card will move ahead while the coin falls in the glass. Why it does so?**

Due to inertia card will continue its motion in the forward direction while coin will remain at rest and will fall in the glass.

>> Question: A bullet has a very small inertia due to its small mass. But why does its impact is so strong when it is fired from the gun?
According to law of conservation of momentum mass of bullet is much smaller than the gun therefore the recoil is much greater than the velocity of gun. Therefore the impact of bullet is very strong.

>> Question: Why the impact of loaded truck on a body coming its way is very large even if the truck is moving slowly.
Greater is the mass of truck greater will be its momentum. Therefore loaded truck has large impact.

>> Question: Explain Newton's first law of motion by practical examples of daily life?
A body continues its state of rest of uniform motion in a straight line provided no net force acts on it. For example

- Objects at rest does not move at their own unless they are moved by some external force.
- Moving bodies cannot stop themselves unless they are stopped by some opposing or frictional force.

>> Question: Why Newton's first law of motion is also known as law of inertia?
Since Newton's first law of motion deals with the inertial property of matter, therefore it is known as law of inertia.

>> Question: Why the passengers standing in a bus fall forward when its driver applies brakes suddenly?
It is because the upper parts of their bodies tend to continue their motion while lower parts of their bodies in contact with the bus stop with it. Hence they fall forward.

>> Question: Define net force.
Net force is the resultant of all the forces acting on a body.

>> Question: State and prove the Newton's second law of motion OR show that F=ma.
When a net force acts on a body, it produces acceleration in the bod in the direction of net force. The magnitude of this acceleration is directly proportional to the net force acting on the body and inversely proportional to its mass.

If a force produces acceleration 'a' in a body of mass 'm' then we can state mathematically that

a $\propto$ F
a $\propto$ 1/m
a $\propto$ F/m
F = ma

>> Question: Define Newton (Unit of Force).
One Newton is the force that produces an acceleration of 1 ms^{-2} in a body of mass of 1 kg.

>> Question: Define Newton's third law of motion.
To every reaction, there is always an equal but opposite reaction.

>> Question: What is Atwood machine?
An Atwood machine is an arrangement of two objects of unequal masses. Both the objects are attached to the ends of a string. The string passes over a frictionless pul ey. This arrangement is sometime used to find the acceleration due to gravity.

>> Question: Why the fragile objects are packed with suitable materials?
Fragile objects such as glass wares etc. are packed with suitable materials such as Styrofoam rings, balls, polythene sheets with air sacks etc.
Air enclosed in the cavities of these materials makes them flexible and soft. During any mishap, they increase the impact time on fragile objects. An increase in impact time lowers the rate of change of momentum and hence lessens the impact of force. This lowers the possible damage due to an accident.

>> Question: Vehicles have rigid cages for passengers with crumple zones at their front and rear ends? Why?
It is for safety purpose. During an accident, crumple zones collapse. This increases the impact time by providing extra time for crumpling. The impact of force is highly reduced and saves the passengers from severe injuries.

>> Question: Define system and isolated system.
- A system is a group of bodies within certain boundaries.
- An isolated system is a group of interacting bodies on which no external force is acting. The momentum of an isolated system is always conserved. This is the law of conservation of momentum.

>> Question: Why a moving ball stops?
A moving ball stops due to friction.

>> Question: Why a bicycle stops when the cyclist stop peddling?
Bicycle stops due to force of friction.

>> Question: What is microscopic concept of friction?
No surface is perfectly smooth. A surface that appears smooth has pits and bumps that can be seen under a microscope. A magnified view of two smooth surfaces in contact shows the gaps and contacts between them. Thus greater is the pressing force greater will be the friction between the sliding surfaces.

>> Question: What is coefficient of friction?
The ratio between the force of limiting friction F_s and the normal reaction R is constant. This constant is called coefficient of friction and is represented by μ.

$\mu = F_s/R$

$F_s = \mu R$

>> Question: The first thing about a wheel is that it rolls as it moves rather than to slide. This greatly reduces friction. Why?

When the axle of a wheel is pushed, the force of friction between the wheel and the ground at the point of contact provides the reaction force. The reaction force acts at the contact points of the wheel in a direction opposite to the applied force. The wheel rolls without rupturing the cold welds. That is why the rolling friction is extremely small than sliding friction.

>> Question: Why ball bearing or roller bearings are used to reduce friction?

The fact that rolling friction is less than sliding friction is applied in ball bearings or roller bearings to reduce losses due to friction.

>> Question: Why it is dangerous to drive on a wet road?

It is dangerous to drive on a wet road because the friction between road and tyres is very small.

>> Question: Describe the advantages of friction?

- It enables animals to walk or crawl without slipping.
- It stops cars, trains, bicycles, MRT trains etc.
- It enables us to hold things firmly with our hands.
- It prevents objects from sliding down a slope.
- It allows nails to hold thing.

>> Question: Describe the disadvantages of friction?

- It causes energy lost and reduces the efficiency of machines.
- It causes rapid wear and tear of the moving parts of machines.

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PROBLEMS

3.1 **A force of 20 N moves a body with an acceleration of 2 ms^{-1}. What is its mass?** **(10 kg)**

Solution: Force = F = 20 N
Acceleration = a = 2 ms^{-2}
Mass = m = ?
F = ma
or $m = \frac{F}{a}$
$m = \frac{20}{2} = 10$ kg

3.2 **The weight of a body is 147 N. What is its mass? (Take the value of g as 10 ms^{-2})** **(14.7 kg)**

Solution: Weight = w = 147 N
Acceleration due to gravity = g = 10 ms^{-1}
Mass m = ?
w = mg
or $m = \frac{w}{g}$
$m = \frac{147}{10}$
m = 14.7 kg

3.3 **How much force is needed to prevent a body of mass 10 kg from falling?** **(100 N)**

Solution: Mass = m = 50 kg
Acceleration = a = g = 10 ms^{-2}
Force = F = ?
F = ma
F = 10×10
F = 100 N

3.4 **Find the acceleration produced by a force of 100 N in a mass of 50 kg.** **(2 ms^{-2})**

Solution: Force = F = 100 N
Mass = m = 50 kg
Acceleration = a = ?
F = ma
or $a = \frac{F}{m}$
$a = \frac{100}{50}$
$a = 2\ ms^{-2}$

3.5 **A body has weight 20 N. How much force is required to move it vertically upwards with an acceleration of 2 ms^{-2} ? (24 N)**

Solution: Weight = w = 20 N
Acceleration = a = 2 ms^{-2}
Vertically upward force (tension) = T = ?

$F_{net} = T - w$

or $ma = T - mg$

or $ma + mg = T$

or $T = m(a + g)$ (i)

Now, $m = \frac{w}{g}$

$m = \frac{20}{10} = 2$ kg

Puting the value of m in Eq (i), we get

$T = 2(2 + 10)$

$= 2(12)$

$T = 24N$

3.6 **Two masses 52 kg and 48 kg are attached to the ends of a string that passes over a frictionless pulley. Find the tension in the string and acceleration in the bodies when both the masses are moving vertically. (500 N, 0.4 ms^{-2})**

Solution: $m_1 = 52$ kg and $m_2 = 48$ kg

(i) Tension $T = ?$

(ii) Acceleration $a = ?$

(i) $T = \frac{2m_1m_2}{m_1 + m_2}g$

$T = \frac{2 \times 52 \times 48}{52 + 48} \times 10$

$T = \frac{49920}{100}$

$T = 499.20 \approx 500$ N

(ii) $a = \frac{m_1 - m_2}{m_1 + m_2}g$

$a = \frac{52 - 48}{52 + 48} \times 10$

$a = \frac{4}{100} \times 10$

$a = 0.4\ ms^{-2}$

3.7 **Two masses 26 kg and 24 kg are attached to the ends of a string which passes over a frictionless pulley. 26 kg is lying over a smooth horizontal table. 24 N mass is moving vertically downward. Find the tension in the string and the acceleration in the bodies. (125 N, 4.8 ms^{-2})**

Solution: $m_1 = 24$kg and $m_2 = 26$kg

(i) Tension in string $T = ?$

(ii) Acceleration $a = ?$

(i) $T = \frac{m_1m_2}{m_1 + m_2}g$

$T = \frac{24 \times 26}{24 + 26} \times 10 = \frac{6240}{50} = 124.8 = 125$ N

(ii) $a = \frac{m_1}{m_1 + m_2} g$

$a = \frac{24}{24 + 24} \times 10 = \frac{24}{30} \times 10 = 4.8\ ms^{-2}$

3.8 How much time is required to change 22 Ns momentum by a force of 20 N? (1.1 s)

Solution: Change in momentum = $P_f - P = 22$ Ns

Force = F = 20N

Time = t = ?

$F = \frac{P_f - P_i}{t}$

or $t = \frac{P_f - P_i}{F}$

$t = \frac{22}{20} = 1.1$ s

3.9 How much is the force of friction between a wooden block of mass 5 kg and the horizontal marble floor? The coefficient of friction between wood and the marble is 0.6. (30 N)

Solution: Mass = m = 5kg

Coefficient of friction = μ = 0.6

Force of friction = F_f = ?

$F_f = \mu R$ where R = mg

$F_f = \mu mg$

$F_f = 0.6 \times 5 \times 10 = 30$ N

3.10 How much centripetal force is needed to make a body of mass 0.5 kg to move in a circle of radius 50 cm with a speed 3 ms^{-1}? (9 N)

Solution: Mass = m = 0.5 kg

Radius of the circle = r = 50 cm = $\frac{50}{100}$ = 0.5 m

Speed = v = 3 ms^{-1}

Centripetal force = F = ?

$F_c = \frac{mv^2}{r}$

$F_c = \frac{0.5 \times 3^2}{0.5}$

$= 9$ N

PHYSICS FOR 9TH CLASS (UNIT # 4)

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SHORT QUESTIONS

>> Question: Define the followings.

Resultant Vector:

A resultant vector is a single vector that has the same effect as the combined effect of all the vectors to be added.

Torque:

The turning effect of a force is called torque or moment of the force

Torque = t = F x L

Torque is vector quantity and its direction can be found by using right hand rule. Its unit is Nm. Torque depends upon two factors.

i) Magnitude of the force (F)

Greater is a force; greater is the moment of the force.

T α F

ii) Moment arm

Larger is the moment arm greater is the moment of the force.

T α L

Center of mass:

Center of mass of a system is such a point where an applied force causes the system to move without rotation.

Center of gravity:

A point where the whole of the body appears to act vertically downward is called center of gravity of a body.

>> Question: Differentiate between followings

Like and unlike forces:

- **Like parallel forces** are the forces that are parallel to each other and have the same direction.
- **Unlike parallel forces** are the forces that are parallel but have directions opposite to each other.

Torque and couple:

- The turning effect of a force is called **torque** or moment of the force.
- When we apply two equal but opposite forces on a body, it forms a **couple**. The turning effect of a couple is the sum of moment of the two forces.

Stable and neutral equilibrium:

- When the center of gravity of a body lies **below** the point of suspension or support, the body is said to be in **stable equilibrium**.
- When the center of gravity of a body lies **above** the point of suspension or support, the body is said to be in **unstable equilibrium**.

>> Question: How head to tail rule helps to find the resultant of forces?

- To add the vectors, draw the representative lines of these vectors in such a way that the head of the first vector coincides with the tail of the second.
- The line joining the tail of the first vector with the head of the second vector represents the resultant vector.
- The direction of the resultant vector is from the tail of the first vector towards the head to second.
- This is called head to tail rule.

>> Question: How can a force be resolved into its rectangular components?

The process of splitting up vectors (forces) into their component forces is called resolution of vectors (forces).

>> Question: What are perpendicular components of a vector.

If a force is formed from two mutually perpendicular components then such components are called its perpendicular components.

>> Question: When a body is said to be in equilibrium?

A body is said to be in equilibrium if no net force acts on it. A body in equilibrium thus remains at rest or moves with uniform velocity. For example a car moving with uniform velocity on a leveled road and an aeroplane flying in the air with uniform velocity are the examples of bodies in equilibrium.

>> Question: Explain the first condition for equilibrium?

A body is said to satisfy first condition for equilibrium if the resultant of all the forces acting on it is zero.

Let n number of forces F1, F2, F3, ... Fn are acting on a body such that

$$F1 + F2 + F3 + \ldots\ldots\ldots\ldots Fn = 0$$

OR

$$\Sigma F = 0$$

OR

$$\Sigma Fx = 0$$
$$\Sigma Fy = 0$$

>> Question: Why there is a need of second condition for equilibrium if a body satisfies first condition for equilibrium?

Case-I:

- First condition for equilibrium does not ensure that a body is in equilibrium.
- Consider a body pulled by the forces F1 and F2.
- The two forces are equal but opposite to each other.
- Both are acting along the same line, hence their resultant will be zero.
- According to the first condition, the body will be in equilibrium.

Case-II:

- If a body has a tendency to rotate then this situation demands another condition for equilibrium in addition to the first condition for equilibrium. This is called second condition for equilibrium.
- As per second condition of equilibrium, a body is said to be in equilibrium when the resultant torque acting on it is zero.
- Mathematically

$$\Sigma t = 0$$

>> Question: Define Second condition of equilibrium.

- As per second condition of equilibrium, a body is said to be in equilibrium when the resultant torque acting on it is zero.
- Mathematically

$$\Sigma t = 0$$

>> Question: Give an example of a moving body which is in equilibrium.

- A car is moving with uniform velocity on a leveled road and an aero plane flying in the air with uniform velocity are the examples of bodies in equilibrium.
- A paratrooper coming down with terminal velocity (constant velocity) also satisfies first condition for equilibrium and is thus in equilibrium.

>> Question: Think of a body which is at rest but not in equilibrium.

- Rest implies stationary; equilibrium implies a resultant force of zero.
- Therefore a body in equilibrium could be moving, for example a sky diver at that a body can be in equilibrium and not at rest, but a body at rest must be in equilibrium, otherwise it would move.
- So, it is impossible.

>> Question: Why a body cannot be in equilibrium due to single force acting on it?

- No, with only a single force present, the body would accelerate infinitely in the direction of that force.
- Because the force which is alone applied will have some direction and the object will try to move in this direction under its influence.
- However, if two opposite and equal forces take part it.
- Gives rise to a null vector force. The body can be in rotational equilibrium under the impact of a single force.

>> Question: Why the height of vehicles is kept as low as possible?

- As the whole weight of a body acts on center of gravity so in case of racing car center of gravity must be close to the earth so that there are less chances of overturning of the car.
- If the car is high, it is easy to produce the torque in car due to large moment arm, and the car can takes the somersault (forward roll).

>> Question: Can the nut of the axle of a bike be loosened with hand why we use a spanner for this purpose?

No, we cannot loosen the nut of the excel of a bike. Normally we use a spanner because a spanner increases the turning effect of the force which easily loosened the nut of excel of a bike.

>> Question: Women and children in the villages often carry pitchers with water on their heads how this is possible?

- Woman and children keep itself upright when carry pitchers on their heads. Pitcher has a heavy semi-spherical base.
- When it is tilted, its centre of mass rises. It returns to its upright position at which its centre of mass is at the lowest.
- That is why Women and children in the villages often carry pitchers with water on their heads.

PHYSICS FOR 9TH CLASS (UNIT # 4)

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>> Question: With a little effort we can learn to balance a stick vertically up on our finger tip how this is possible.

- In order to balance something, the center of gravity of the object is either directly above or directly below the pivot point.
- An example would be balancing the stick on the end of a finger with the stick pointing vertically up.
- If you do this you will find that the stick wants to fall over, and you need to keep moving your finger around to keep this from happening.

>> Question: Many people push a bus to start it why all of them push it in the same direction?

Like parallel forces acting in the same direction increases the resultant force which moves the bus easily.

>> Question: What is meant by trigonometry?

Trigonometry is that branch of mathematics which deals with the properties of a right angled triangle.

>> Question: Why it is easy to open and close the door by pulling or pushing it at its handle?

We open or close a door by pushing or pulling it. Here push or pull turn the door about its hinge or axis of rotation. The door is opened or closed due to the turning effect of the force acting on it.

>> Question: What do you mean by a rigid body?

- A body is composed of large number of small particles. If the distances between all pairs of particles of the body do not change by applying a force then it is called a rigid body.
- In other words, a rigid body is the one that is not deformed by force or forces acting on it.

>> Question: What do you mean by axis of rotation?

Consider a rigid body rotating about a line. The particles of the body move in circles with their centers all lying on this line. This line is called the axis of rotation of the body.

>> Question: Why the handle of a door is fixed near the outer edge of a door? OR Why door handles usually on the opposite edge of the door from the hinge?

We can open or close a door more easily by applying a force at the outer edge of a door rather than near the hinge.

The moment produced by a force using a greater moment arm is greater than the torque produced by the same force using by shorter moment arm. Therefore the handle of a door is fixed near the outer edge of a door. (T α L)

>> Question: Why it is easy to tighten a nut using a spanner of longer arm than a spanner of shorter arm?
A spanner having long arm helps to loosen or tighten a nut or a bolt with greater ease than the one having short arm. It is because the turning effect (torque) of the force increases. (t α L)

>> Question: What do you mean by line of action of a force?
The line along which a force acts is called the line of action of the force.

>> Question: Define moment arm.
The perpendicular distance between the axis of rotation and the line of action of the force is called the moment arm of the force. It represented by the distance L.

>> Question: What do you mean by newton-metre (Nm)?
A torque of 1 N m is caused by a force of 1 N acting perpendicular to the moment arm 1 m long.

>> Question: Describe principle of moment?
A body is balanced if the sum clockwise moments acting on the body is equal to the sum of anticlockwise moments acting on it
Explanation:
Clockwise moment:
A force that turns a spanner in the clockwise direction is generally used to tighten a nut. The torque or moment of the force so produced is called clockwise moment.
Anticlockwise moment:
To loosen a nut, the force is applied such that it turns the nut in the anticlockwise direction. The torque or moment of the force so produced is called anticlockwise moment.

>> Question: Two children are -sitting on the see-saw, such that they cannot swing. What is the net torque in this situation?
Net torque in the situation is zero. Because clockwise torque will cancel the effect of anticlockwise torque.

>> Question: Explain how center of mass helps the system to move as well as rotate?
Centre of mass of a system is such a point where an applied force causes the system to move without rotation.
Explanation:
It is observed that the centre of mass of a system moves as If its entire mass is confined at that point. A force applied at such a point in the body does not produce any torque in it i.e. the body moves in the direction of net force F without rotation.

>> Question: Define centre of gravity?
A point where the whole weight of the body appears to act vertically downward is called centre of gravity of a body.

>> Question: How does a paratrooper come down?

- A paratrooper comes down with terminal velocity is in equilibrium.
- A paratrooper coming down with terminal velocity (constant velocity) also satisfies first condition for equilibrium and is thus in equilibrium.

>> Question: Define terminal velocity?

The maximum and constant velccity of an object falling vertically downward is called terminal velocity.

>> Question: Does the speed of ceiling fan go on increasing all the time?

No, the speed of a ceiling fan does not go' on increasing all the time. Fan will move with constant speed.

>> Question: Does the fan satisfy second condition for equilibrium when rotating with uniform speed?

Yes, a rotating ceiling fan satisfy second condition for equilibrium. Because ceiling fan rotating at constant speed is in equilibrium as net torque acting on it is zero.

>> Question: Why a vehicle is made heavy at its bottom?

- A vehicle is made heavy at its bottom to keep its centre of gravity as low as possible. A lower centre of gravity keeps it stable.
- Moreover, the base of a vehicle is made wide so that the vertical line passing through its centre of gravity should not get out of its base during a turn.

LONG QUESTIONS

>> Question: Explain the states/types of equilibrium:

There are three states of equilibrium.

i) Stable equilibrium
ii) Unstable equilibrium
iii) Neutral Equilibrium.

Stable Equilibrium:

- When the center of gravity of a body lies **below** the point of suspension or support, the body is said to be in **stable equilibrium**.
- **For example** a body lying on a horizontal surface is an example of stable equilibrium. If the book is lifted from on edge and then allcwed to fall, it will come back to its original position.
- The **reason for its stability** is this, when the book is lifted its center of gravity is raised. The line of action of weight passes through the base of the book. A torque due to weight of the book brings it back to the original position.

Unstable Equilibrium:

- When the center of gravity of a body lies **above** the point of suspension or support, the body is said to be in **unstable equilibrium**.
- For example pencil standing on its point or a stick in vertically standing position.
- The reason for instability is this when the pencil is slightly disturbed its center of gravity is lowered. The line of action of its weight lies outside the base of pencil.

Neutral Equilibrium:

- When the center of gravity of a body lies at the point of suspension or support, the body is said to be in neutral equilibrium. For example rolling ball.
- The reason for neutral equilibrium is that if the ball is rolled, its center of gravity is neither raised nor lowered.

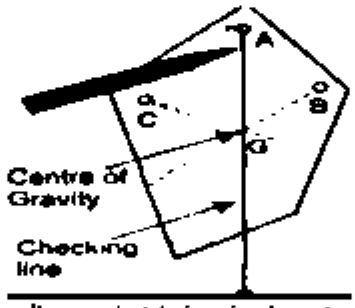
>> Question: Explain an experiment to find the centre of gravity of a an irregular shaped thin lamina?

A simple method to find the centre of gravity of a body is by the use of a plumb line.

Plumb line:

- A plumb line consists of a small metal bob supported by a string.
- When the bob is suspended freely by the string, it rests along the vertical direction due to its weight acting vertically downward.

Experiment:



- Take an irregular piece of cardboard. Make holes A, B and C near its edge.
- Fix a nail on a wall.
- Support the cardboard on the nail through one of the holes (let it be A), so that the cardboard can swing freely about A.
- The cardboard will come to rest with its centre of gravity just vertically below the nail.
- Vertical line from A can be located using a plumb line hung from the nail
- Mark the line on the cardboard behind the plumb line.
- Repeat it by supporting the cardboard from hole B.
- The line from B will intersect at a point G.
- Similarly, draw another line from the hole C. Note that this line also passes through G.
- It Will be found that all the vertical lines from holes A, B and C have a common point G.
- This common point G is the centre of gravity of the cardboard.

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PHYSICS FOR 9TH CLASS (UNIT # 4)

4.1 Find the resultant of the following forces:
(i) 10 N along x-axis (ii) 6 N along y-axis and
(iii) 4 N along negative x-axis. (8.5 N making 45° with x-axis)

Solution: F_x = Net force along x-axis = 10 − 4 = 6 N
F_y = Force along y-axis = 5 N
Magnitude of the resultant force = F = ?
Direction of the force = θ = ?

$$F = \sqrt{F_x^2 + F_y^2}$$
$$F = \sqrt{(6)^2 + (5)^2}$$
$$F = \sqrt{36 + 36}$$
$$= \sqrt{72} = 8.5 \text{ N}$$

Now, $\theta = \tan^{-1}\frac{F_y}{F_x}$
$\theta = \tan^{-1}$
$\theta = \tan^{-1}(1)$
$\theta = 45°$ with x axis

4.2 Find the perpendicular components of a force of 50 N making an angle of 30° with x axis. (43.3 N, 25 N)

Solution: Force F = 50N
Angle $\theta = 30°$
F_x = ? and F_y = ?
$F_x = F \cos\theta$
$F_x = 50 \times \cos 30°$
$= 50\text{N} \times 0.866$ ($\because \cos 30° = 0.866$)
$F_x = 43.3\text{N}$
Similarly, $F_y = F \sin\theta$
$F_y = 50 \times 0.5$ ($\because \sin 30° = 0.5$)
$F_y = 25\text{N}$

4.3 Find the magnitude and direction of a force, if its x-component is 12 N and y- component is 5N. (13 N making 22.6° with x-axis)

Solution: $F_x = 12\text{N}$
$F_y = 5\text{N}$
(i) Magnitude of the force = F = ?
(ii) Direction of the force = θ = ?

$$F = \sqrt{F_x^2 + F_y^2}$$
$$F = \sqrt{(12)^2 + (5)^2}$$
$$F = \sqrt{144 + 25}$$
$$= \sqrt{169}$$
$$F = 13\text{ N}$$

(ii) $\theta = \tan^{-1}\frac{F_y}{F_x}$
$\theta = \tan^{-1}\frac{12}{5}$
$\theta = \tan^{-1}(2.4)$
$\theta = 22.6°$ with x-axis

4.4 A force of 100 N is applied perpendicularly on a spanner at a distance of 10 cm from a nut. Find the torque produced by the force. (10 Nm)

Solution: Force = F = 100 N
Distance = L = 10 cm = 0.1 m
Torque = τ = ?
$\tau = F \times L$
$\tau = 100 \times 0.1$
$= 100 \times \frac{1}{10} = 10$ Nm

4.5 A force is acting on a body making an angle of 30° with the horizontal. The horizontal component of the force is 20 N. Find the force. (23.1 N)

Solution: Angle $\theta = 30°$ (with x-axis)
Horizontal component of force $F_x = 20N$
Force $F = ?$
$F_x = F\cos\theta$
$20N = F \cos 30°$
or $20N = F \times 0.866$ $(\because \cos 30° = 0.866)$
or $F = \frac{20N}{0.866} = 23.09$
$F = 23.1N$

4.6 The steering of a car has a radius 16 cm. Find the torque produced by a couple of 50 N. (16 Nm)

Solution: Radius $= r = L = 16\ cm = \frac{16}{100}\ m = 0.16m$
Couple arm $= L = 16\ cm = \frac{16}{100}\ m = 0.16m$
Force $= F = 50\ N$
Torque $= \tau = ?$
$\tau = F \times L$
$\tau = 50 \times (2 \times 0.16) = 16\ Nm$

4.7 A picture frame is hanging by two vertical strings. The tensions in the strings are 3.8 N and 4.4 N. Find the weight of the picture frame. (8.2 N)

Solution: Tension $T_1 = 3.8N$
Tension $T_2 = 4.4N$
Weight of the picture frame $= w = ?$
When the picture frame is in equilibrium, then
$\Sigma F_x = 0$ and $\Sigma F_y = 0$
Therefore $T - w = 0$
or $(T_1 + T_2) - w = 0$
$T_1 + T_2 = w$
$3.8 + 4.4 = w$
$w = 8.2\ N$

4.8 Two blocks of masses 5 kg and 3 kg are suspended by the two strings as shown. Find the tension in each string. (80 N, 30 N)

Solution: Mass of large block $= M = 5$ kg
Mass of small block $= m = 3$ kg
Tension produced in each string $= T_1 = ?$ and $T_2 = ?$
$T_1 = w_1 + w_2$
$T_1 = mg + Mg$
$T_1 = (m + M)g$
$T_1 = (3 + 5) \times 10$
$= 8 \times 10$
$= 80\ N$
Also, $T_2 = mg$
$T_2 = 3 \times 10 = 30\ N$

4.9 A nut has been tightened by a force of 200 N using 10 cm long spanner. What length of a spanner is required to loosen the same nut with 150 N force? (13.3 cm)

Solution: Force = F_1 = 200 N

Length = L_1 = 10 cm = $\frac{10}{100}$ = 0.1 m

Length of the spanner to tighten the same nut:

Force = F_2 = 150 N

Length = L_2 = ?

Since $\tau_1 = \tau_2$

$F_1 \times L_1 = F_2 \times L_2$

$200 \times 0.1 = 150 \times L_2$

$20 = 150 \times L_2$

$L_2 = \frac{20}{150} = 0.133\ m = 0.133 \times 100 = 13.3\ cm$

4.10 A block of mass 10 kg is suspended at a distance of 20 cm from the centre of a uniform bar 1 m long. What force is required to balance it at its centre of gravity by applying the force at the other end of the bar? (40 N)

Solution: Mass of the block = m = 10 kg

Length of the bar = l = 1 m

Moment arm of $w_1 = L_1$ = 20 cm = 0.2 m

Moment arm of $w_2 = L_2$ = 50 cm = 0.5 m

Force required to balance the bar F_2 = ?

By applying principle of moments.

Clockwise moments = Anticlockwise moments

Thus $F_1 \times L_1 = F_2 \times L_2$

$mg \times L_1 = F_2 \times L_2$

$(10 \times 10) \times 0.2 = F_2 \times 0.5$

$20 = F_2 \times 0.5$

$F_2 = \frac{20}{0.5} = \frac{200}{5} = 40$ N

PHYSICS FOR 9TH CLASS (UNIT # 5)

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SHORT QUESTIONS

>> Question: Who gave the idea of gravity?

- Isaac Newton introduced the idea of gravity.
- In 1665 he was trying to solve the mystery why planets revolve around the Sun.
- Suddenly an apple fell from the tree under which he was sitting. The idea of gravity flashed in his mind.

>> Question: What is meant by the force of gravitation?

There exists a force due to which everybody of the universe attracts every other body. This force is called the force of gravitation.

>> Question: Explain that the gravitational forces are consistent with Newton's third law of motion?

- It is to be noted that mass m1 attracts m2 towards it with a force F while mass m2 attracts m1 towards it with a force of the same magnitude F but in opposite direction.
- If the force acting on m1 is considered as action then the force acting on m2 will be the reaction.
- This is in consistence with Newton's third law of motion

>> Question: Define gravitational field?

The field in a region in space in which a particle would experience a gravitational force is called gravitational field.

>> Question: Explain what is meant by gravitational field strength?

- In the gravitational field of the Earth, the gravitational force per unit mass is called the gravitational field strength of the Earth.
- It is 10 N kg^{-1} near the surface of the Earth.
- The gravitational field becomes weaker and weaker as we go farther and farther away from the Earth.

>> Question: Does an apple attract the Earth towards it?

Yes, as per law of gravitation apple will attract earth, but it is very low force.

>> Question: Does the weight of an apple increase, decrease or remain when taken to the top of a mountain?

The value of g varies inversely as the square of the distance. Therefore the weight of an apple, decrease when taken to the top of a mountain due to less gravity of Earth

>> Question: What is Satellite?

An object that revolves around a planet is called a satellite. The moon revolves around the Earth so moon is a natural satellite of the Earth.

>> Question: What is an artificial satellite?

Scientists have sent many objects into space. Some of these objects revolve around the Earth. These are called artificial satellites.

>> Question: What is Global Positioning System (GPS)?

Global Positioning System (GPS) is a satellites navigation system. It helps us to find the exact position of an object anywhere on the land, on the sea or in the air. GPS consists of 24 Earth satellites. These satellites revolve around the Earth twice a day with a speed of 3.87 kms^{-1}.

>> Question: What are geostationary satellites also write their uses.

Geostationary satellites whose velocity relative to Earth is zero. These satellites remain stationary with respect to the Earth at a height of about 42300 km from the surface of Earth. These are used for global TV transmissions and for other telecommunication purposes.

Uses of geostationary satellites:

Such satellites are useful for the following purposes.

(i) Worldwide communication (ii) Weather observations
(iii) Navigation (iv) Other military uses

>> Question: What is a field force?

The gravitational pull of the Earth acting on the body whether the body is in contact with the Earth or not is called field force.

>> Question: Why earlier scientists could not guess about the gravitational force?

Earlier scientists could not guess the force of gravitation between two masses, because it is of very small value. It could be detected only by very sensitive instrument which were not invented at that time.

>> Question: Why does the value of g vary from place to place?

The value of g is inversely proportional to the square of the radius of the Earth

$g \propto 1/R^2$

But it does not remain constant. It decreases with altitude. Alt tude is the height of an object or place above sea level. The value of g is greater at sea level than at the hills.

>> Question: How Newton's law of gravitation helps in understanding the motion of satellites?

A satellite requires centripetal force that keeps it to move around the Earth. The gravitational force of attraction between the satellite and the Earth provides the necessary centripetal force.

>> Question: On what factors the orbital speed of a satellite depends?

Since orbital speed = $V_o = \sqrt{gh\,(R+h)}$

Formula shows that orbital speed of a satellite depend upon g, R and h. The orbital velocity of the satellite depends on its altitude above Earth. The nearer Earth, the faster the required orbital velocity.

>> Question: Why communication satellites are stationed at geostationary orbits?

Communications satellites and weather satellites are often given geostationary orbits, so that the satell1te antennas that communicate with them do not have to move to track them, but can be pointed permanently at the position in the sky where they stay. A geostationary orbit Is a particular type of geosynchronous orbit.

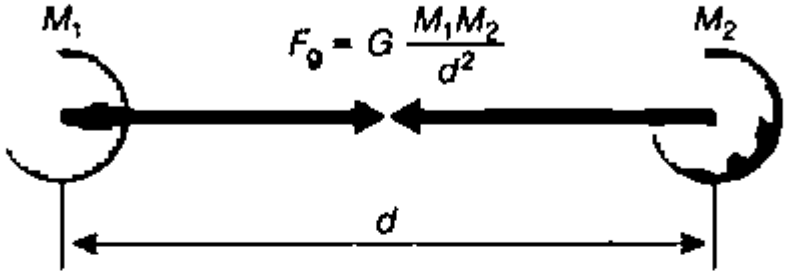
LONG QUESTIONS

>> Question: Explain the law of gravitation.

Everybody in the universe attracts every other body with a force which is directly proportional to the product of their masses and inversely proportional to the square of the distance between their centers.

Explanation:

Consider two bodies of masses m1 and m2. The distance between the centers of masses is d.



According to the law of gravitation, the gravitational force of attraction F with which the two masses m1 and m2 separated by a distance d attract each other is given by:

$$F \propto m_1m_2$$
$$F \propto 1/d^2$$

$$F \propto \frac{m_1m_2}{d^2}$$

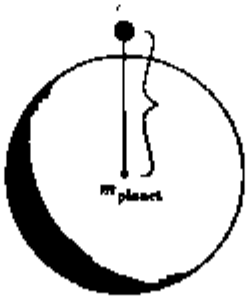
$$F = G\frac{m_1m_2}{d^2}$$

Universal constant of gravitation (G):

Here G is the proportionality constant. It is called the universal constant of gravitation. Its value is same everywhere. In SI units the value of G is 6.673×10^{-11} $Nm^2\ kg^{-2}$.

>> Question: How the mass of Earth can be determined?

Consider a body of mason the surface of the Earth. Let the mass of the Earth be Me and radius of the Earth be R.



According to the law of gravitation, the gravitational force F of the Earth acting on a body is given by

$$F = G \frac{mMe}{R^2}$$

$$F = mg$$

$$mg = G \frac{mMe}{R^2}$$

$$g = G \frac{Me}{R^2}$$

$$Me = \frac{R^2 g}{G}$$

$$Me = \frac{(6.4 \times 10^6)^2 (10)}{(6.673 \times 10^{-11})} = 6.0 \times 10^{24} \text{ kg}$$

>> Question: Can you determine the mass of our moon? If yes then what you need to know?

Yes, we can find the mass of moon by using the law of gravitation.

$$M_m = \frac{R^2 g_m}{G}$$

Where

M_m = mass of moon
R = radius of moon
g_m = gravitational acceleration on moon
G = gravitational 'constant= 6.673×10^{-11} $Nm^2 kg^{-2}$

>> Question: Why law of gravitation is important to us?

- As universal law of gravitation is important in releasing satellites from the earth in the orbits and it also gives the reason that why earth revolves around the sun.
- The universal law of gravitation describes the phenomenon like the gravitational force between a planet and a star, rotation and revolution of heavenly bodies and galaxies.

>> Question: How can you save that gravitational force is a field force?

- It is true the force of gravity can be described as a force field. Any object having mass will create a gravitational attraction in all directions, with decreasing intensity as the distance from the object increases.
- The weight of a body is due to the gravitational force with which the Earth attracts a body. Gravitational force is a non-contact force.
- For example, the velocity of a body, thrown up, goes on decreasing while on return its velocity goes on increasing. This is due to the gravitational pull of the Earth acting on the body whether the body is in contact with the Earth or not. Such a force is called the field force. It is assumed that a gravitational field exists all around the Earth.

>> Question: Explain the variation of g with altitude. OR
What is the effect of the following on the gravitational acceleration?

Mass of a freely falling body:

Value of g does not depend on mass of the body. This means that light and heavy bodies should fall toward the centre of earth with the same acceleration.

Distance of freely falling body from the centre of the Earth:

The value of g varies inversely as the square of the distance. If the distance from the centre of the earth is increased then the value or g will decrease. That is why the value of g at hills (Murree) is Jess than its value on the Sea shore (Karachi).

Is there any difference between the values of g at the equator and at the poles:

Earth is not a perfect sphere. It is flattened at the poles for this reason the value of g at the pole is more than at the equator. Because polar radius is less than equatorial radius.

>> Question: Do you attract the Earth or the Earth attracts you? Which one is attracting with a larger force? You or the Earth.

- First, we can use Newton's Third Law. If Object "A" exerts a force on object "B", then object "B" will exert an equal force back on "A". This makes it pretty clear the forces are equal.
- Second, we can use Newton's Law of Gravitational force. "The force that one mass exerts on a second mass is proportional o the product of the two masses". This means if we calculate the force the Earth exerts on us, we multiply the Earth's mass times our mass. And if we calculate the force we exert on the Earth, we again multiply the two masses. Another words we do the exact same calculation, so we will get the same answer.

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PROBLEMS

5.1 Find the gravitational force of attraction between two spheres each of mass 1000 kg. The distance between the centres of the spheres is 0.5 m. **(2.67×10^{-4} N)**

Solution: Mass = $m_1 = m_2 = 1000$ kg
Distance between the centres = $d = 0.5$ m
Gravitational constant = $G = 6.673 \times 10^{-11}$ Nm^2kg^{-2}
Gravitational force = $F = ?$

$$F = G\frac{m_1 m_2}{d^2}$$

$$F = 6.673 \times 10^{-11} \times \frac{1000 \times 1000}{(0.5)^2}$$

$$= 6.673 \times 10^{-11} \times \frac{(10)^6}{0.25} = \frac{6.673 \times 10^{-11} \times 10^6}{0.25} = \frac{6.673 \times 10^{-5}\ Nm^2}{0.25}$$

$$= 26.692 \times 10^{-5} = 2.67 \times 10^{-4}\ N$$

5.2 The gravitational force between two identical lead spheres kept at 1 m apart is 0.006673 N. Find their masses. **(10,000 kg each)**

Solution: Gravitational force = $F = 0.006673$ N
Gravitational constant = $G = 6.673 \times 10^{-11}$ Nm^2kg^{-2}
Distance between the masses = $d = 1$m
Masses = $m_1 = m_2 = ?$

$$F = G\frac{m_1 m_2}{d^2}$$

or $$F = G\frac{m \times m}{d^2} \qquad (\text{Let } m_1 = m_2 = m)$$

or $$F = G\frac{m^2}{d^2}$$

or $$m^2 = \frac{F \times d^2}{G}$$

$$m^2 = \frac{0.006673 \times (1)^2}{6.673 \times 10^{-11}} = \frac{6.673 \times 10^{-3}}{6.673 \times 10^{-11}} = \frac{6.673 \times 10^{-3}}{6.673 \times 10^{-11}}$$

$$m^2 = 10^8 \Rightarrow \sqrt{m^2} = \sqrt{10^8}$$

$$m = 10^4 = 10000 \text{ kg each}$$

Therefore, mass of each lead sphere is 10000kg.

5.3 Find the acceleration due to gravity on the surface of the Mars. The mass of Mars is 6.42×10^{23} kg and its radius is 3370 km. **($3.77\ ms^{-2}$)**

Solution: Mass of Mars = $M_m = 6.42 \times 10^{23}$ kg
Radius of Mars = $R_m = 3370$ km = 3370×1000 m = 3.37×10^6 m
Acceleration due to gravity on the surface of Mars = $g_m = ?$

or $$g_m = G\frac{M_m}{R_m^2}$$

$$g_m = 6.673 \times 10^{-11} \times \frac{6.42 \times 10^{23}}{(3.37 \times 10^6)^2}$$

$$= 3.77\ ms^{-2}$$

4 The acceleration due to gravity on the surface of moon is 1.62 ms^{-2}. The radius of Moon is 1740 km. Find the mass of moon. **(7.35×10^{22} kg)**

lution: Acceleration due to gravity = $g_m = 1.62\ ms^{-2}$
Radius of moon = $R_m = 1740\ km = 1740 \times 1000\ m = 1.74 \times 10^6\ m$
Mass of moon = $M_m = ?$

$$g_m = \frac{GM_m}{R^2_m}$$

or $$M_m = \frac{g_m \times R^2_m}{G}$$

$$M_m = \frac{1.62 \times (1.74 \times 10^6)^2}{6.673 \times 10^{-11}} = \frac{1.62 \times 3 \times 10^{12}}{6.673 \times 10^{-11}} = \frac{4.86 \times 10^{12} \times 10^{11}}{6.673}$$

$$M_m = 7.35 \times 10^{22}\ kg$$

5 Calculate the value of *g* at a height of 3600 km above the surface of the Earth. **($4.0\ ms^{-2}$)**

lution: Height = $h = 3600\ km = 3600 \times 1000\ m = 3.6 \times 10^6\ m$
Mass of Earth = $M_e = 6.0 \times 10^{24}\ kg$
Gravitational acceleration $g_h = ?$

$$g_h = \frac{GM_e}{(R_e+h)^2}$$

$$g_h = 6.673 \times 10^{-11} \times \frac{6.0 \times 10^{24}}{(6.4 \times 10^6 + 3.6 \times 10^6)^2}$$

$$= 6.673 \times 10^{-11} \times \frac{6.0 \times 10^{24}}{(10.0 \times 10^6)^2} = 6.673 \times 10^{-11} \times \frac{6.0 \times 10^{24}}{100 \times 10^{12}}$$

$$= 6.673 \times 10^{-11} \times 6.0 \times 10^{10} = 40 \times 10^{-1} = 4.0\ ms^{-2}$$

6 Find the value of g due to the Earth at geostationary satellite. The radius of the geostationary orbit is 48700 km. **($0.17\ ms^{-2}$)**

lution: Radius = $R = 48700 \times 1000\ m = 4.87 \times 10^7\ m$
Acceleration due to gravity = $g = ?$

$$g = \frac{GM_e}{R^2}$$

$$g = 6.673 \times 10^{-11} \times \frac{6.0 \times 10^{24}}{(4.87 \times 10^7)^2} = 6.673 \times 10^{-11} \times \frac{6.0 \times 10^{24}}{23.717 \times 10^{14}}$$

$$= \frac{6.673 \times 6.0 \times 10^{-1}}{23.717} = \frac{4.0038}{23.717} = 0.17 ms^{-2}$$

7 The value of g is 4.0 ms^{-2} at a distance of 10000 km from the centre of the Earth. Find the mass of the Earth. **(5.99×10^{24} kg)**

lution: Gravitational acceleration = $g = 4.0 ms^{-2}$
Radius of Earth = $R_e = 10000 km = 10000 \times 1000\ m = 10^7\ m$
Mass of Earth = $M_e = ?$

$$M_e = \frac{gR^2}{G}$$

$$M_e = \frac{4.0 \times (10^7)^2}{6.673 \times 10^{-11}} = \frac{4.0 \times 10^{14}}{6.673 \times 10^{-11}} = \frac{4.0 \times 10^{14}}{6.673 \times 10^{-11}}$$

$$= 0.599 \times 10^{25} = 5.99 \times 10^{24}\ kg$$

8 At what altitude the value of *g* would become one fourth than on the surface of the Earth? **(one Earth's radius)**

lution: Mass of Earth = $M_e = 6.0 \times 10^{24}\ kg$
Radius of Earth = $R_e = 6.4 \times 10^6\ m$

Acceleration due to gravity $g_h = \frac{1}{4}g = \frac{1}{4} \times 10\ ms^{-2} = 2.5\ ms^{-2}$

Altitude above Earth's surface = h = ?

$$g_h = \frac{GM_E}{(R+h)^2}$$

or $(R + h)^2 = \frac{GM_E}{g_h}$

Taking square root on both sides

or $\sqrt{(R+h)^2} = \sqrt{\frac{GM_E}{g_h}}$

or $R + h = \sqrt{G\frac{M_E}{g_h}}$

or $h = \sqrt{G\frac{M_E}{g_h}} - R$

or $h = \sqrt{\frac{6.673 \times 10^{-11} \times 6.0 \times 10^{24}}{2.5}} - 6.4 \times 10^6$

$= \sqrt{\frac{40.038 \times 10^{13}}{2.5}} - 6.4 \times 10^6 = \sqrt{16 \times 10^{12}\ m^2} - 6.4 \times 10^6$

$= \sqrt{0.16 \times 10^{12}} - 6.4 \times 10^6 = 0.4 \times 10^6 - 6.4 \times 10^6$

$= -6.0 \times 10^6$ m

- As height is always taken as positive, therefore

  $h = 6.0 \times 10^6$ m = One Earth's radius

5.9 A polar satellite is launched at 850 km above Earth. Find its orbital speed. (7431 ms^{-1})

Solution: Height = h = 850 km = 850 × 1000 m = 0.85×10^6 m

Orbital velocity = v_o = ?

$$v_o = \sqrt{\frac{GM_E}{R+h}}$$

$$v_o = \sqrt{\frac{6.673 \times 10^{-11} \times 6 \times 10^{24}}{6.4 \times 10^6 + 0.85 \times 10^6}} = \sqrt{\frac{40.038 \times 10^{13}}{7.25 \times 10^6}}$$

$= \sqrt{5.55 \times 10^7} = \sqrt{55.5 \times 10^6}$

$= 7.431 \times 10^3 = 7431\ ms^{-1}$

5.10 A communication satellite is launched at 42000 km above Earth. Find its orbital speed. (2876 ms^{-1})

Solution: Height = h = 42000km = 42000 × 1000m = 42×10^6 m

Orbital velocity = v_o = ?

$$v_o = \sqrt{\frac{GM_E}{R+h}}$$

$$v_o = \sqrt{\frac{6.673 \times 10^{-11} \times 6 \times 10^{24}}{6.4 \times 10^6 + 42 \times 10^6}}$$

$$= \sqrt{\frac{40.038 \times 10^{13}}{48.4 \times 10^6}}$$

$$= \sqrt{\frac{400.38 \times 10^{12}}{48.4 \times 10^6}} = \sqrt{8.27 \times 10^6}$$

$= 2.876 \times 10^3 = 2876\ ms^{-1}$

SHORT QUESTIONS

Question: Define work. What is its SI unit?

Work is done when a force acting on a body displaces it in the direction of a force. Work is a scalar quantity. It depends on the force acting on a body, displacement of the body and the angle between them.

Work done = Force x displacement

W = FS

Unit of work:

SI unit of work is joule (J). It is defined as:

The amount of work is one joule when a force of one Newton displaces a body through one metre in the direction of force.

Question: Derive the relation for work done by a force inclined with the displacement?

Let the force F is making an angle 0 with the surface on which the body is moved. Resolving F into its perpendicular components F_x and F_y as,

F_x = F cos 0

F_y = F sin 0

In case when force and displacement are not parallel then only the X-component Fx parallel to the surface causes the body to move on the surface and not the y-component Fy.

Question: Define energy, give two types of mechanical energy.

A body possesses energy if it is capable to do work.

Types of mechanical energy:

Mechanical energy possessed by a body is of two types:

i) Kinetic energy
ii) Potential energy.

Question: List the different forms of energy with examples?

Energy exists in various forms. Some of the main forms of energy are given:

i) Mechanical Energy
ii) Heat Energy
iii) Electrical Energy
iv) Sound Energy
v) Light Energy
vi) Chemical Energy
vii) Nuclear Energy

Question: Describe mechanical energy with examples.

- The energy possessed by a body both due to its motion or position is called mechanical energy.
- For example Water running down a stream, wind, a moving car, a lifted hammer, a stretched bow, a catapult or a compressec spring etc. possesses mechanical energy.

Question: Describe heat energy with examples?

Heat is a form of energy given out by hot bodies. Large amount of heat is obtained by burning fuel. Heat is also produced when motion is opposed by frictional forces. The foods we take provide us heat energy.

Examples:

The sun is the main source of heat energy.

Question: Describe electrical energy with examples?

Electricity is one of the widely used form of energy. Electrical energy can be supplied easily to any desired place through wires.

Examples:

We get electrical energy from batteries and electric gererators. These electric generators are run by hydro power, thermal or nuclear power.

Question: Describe sound energy with examples?

When you knock at the door, you produce sound. Sound is a form of energy.

Examples:

It s produced when a body vibrates; such as vibrating diaphragm of a drum, vibrating strings of a sitar and v brating air column of wind instruments such as flute pipe etc.

Question: Describe light energy with examples?

Light is an important form of energy. Name some sources of light that you come across. Plants produce food in the presence of light. We also need light to see things.

Examples:

We get light from candles, electric bulbs, fluorescent tubes and also by burning fuel. However most of the light comes from the sun.

Question: Describe chemical energy with examples?

- Chemical energy is present in food, fuels and in other substances. We get other forms of energy from these substances during chemical reactions.
- The burning of wood, coal or natural gas in air is a chemical reaction which releases energy as heat and light.
- Electric energy is obtained from electric cells and batteries as a result of chemical reaction between various substances present in them.
- Animals get heat and muscular energy from the food they eat.

Question: Describe nuclear energy with examples?

Nuclear energy is he energy released in the form of nuclear radiations in addition to heat and light during nuclear reactions such as fission and fusion reactions. Heat energy released in nuclear reactors is converted into electrical energy.

Examples:

The energy coming from the Sun for the last billions of years is the result of nuclear reactions taking place on the Sun.

Question: What is Pole vaulter?

A pole vaulter uses a flexible vaulting pole made of special material. It is capable to store all the vaulter's kinetic energy while bending to the form of potential energy. The vaulter runs as fast as possible to gain speed. The kinetic energy gained by the vaulter due to speed helps him/her to rise up as the vaulter straightens. Thus he attains height as the pole returns the potential energy stored by the vaulter in the pole.

Question: List the major sources of energy?

i) Fossil fuels
ii) Nuclear fuels
iii) Energy from biomass
iv) Energy from water
v) Energy from the sun
vi) Solar house heating
vii) Solar cells
viii) Wind energy
ix) Geothermal energy

Question: Differentiate energy resources as renewable and non-renewable resources of energy with examples of each?

Renewable sources of energy are those which can be reused. They do not get extinguished. They are environmentally friendly. They do not cause pollution.

Examples:

Solar energy, wind energy and tidal energy.

Non-renewable sources of energy are those which cannot be reused. They get extinguished. They cause pollution and are environmentally harmful.

Examples:

Plastic, wood, petroleum, oil, etc.

Question: List non-renewable sources of energy?

i. Fossil fuels
ii. Nuclear fuels

Question: Describe the harmful waste products released by fossil fuels? List the Environmental issues associated with fossil fuels?

Fossil fuels release harmful waste products. These wastes include carbon mono-oxide and other harmful gases, wh1ch pollute the environment. This causes serious health problems such as headache, tension, nausea, allergic reactions, irritation of eyes, nose and throat. Long exposure of these harmful gases may cause asthma, lungs cancer, heart diseases and even damage to brain, nerves and other organs of our body.

Describe the processes by which energy is converted from one form to another with reference to nuclear fuels? OR List the Environmental issues associated with nuclear fuels?

- In nuclear power plants, we get energy as a result of fission reaction. During fission reaction, heavy atoms, such as Uranium atoms, split up into smaller parts releasing a large amount of energy.

- Nuclear power plants give out a lot of nuclear radiations and vast amount of heat. A part of this heat is used to run power plants while lot of heat goes waste into the environment.

Question: List non-renewable sources of energy?

i. Energy from water
ii Energy from the sun
iii. Solar house heating
iv. Solar cells
v. Wind energy
vi. Geothermal energy
vii. Energy from biomass

Sunlight and water power are the renewable sources of energy. They will not run out like coal, oil and gas.

Question: How energy is obtained from water?

Energy from water power is very cheap. Dams are being constructed at suitable locations in different parts of the world. Dams serve many purposes. They help to control floods by storing water. The water stored in dams is used for irrigation and also to generate electrical energy without creating much environmental problems.

Question: How energy is obtained from sun?

Solar energy is the energy coming from the Sun and is used directly and indirectly. Sunlight does not pollute the environment in any way. The sunrays are the ultimate source of life on the Earth. We are dependent on the Sun for all our food and fuels. If we find a suitable method to use a fraction of the solar energy reaching the Earth, then it would be enough to fulfill our energy requirement.

Question: Explain the functioning of solar house heating system?

Complete solar house heating systems are successfully used in areas with a minimum amount of sunshine in winter. A heating system consists of:

i. A collector
ii. A storage device
iii. A distribution system

Working of solar heating system:

A solar collector made of glass panels over blank metal plates. The plates absorb the Sun's energy which heats a liquid flowing in the pipes at the back of the collector. The hot water can be used for cooking, washing and heating the buildings.

Uses of solar energy:

Solar energy is used in solar cookers, solar distillation plants, solar power plant, etc.

Question: State mass energy equation $E = mc^2$

Einstein predicted the inter-conversion of matter and energy. According to him, a loss in the mass of a body provides a lot of energy. This happens in nuclear reactions. The relation between mass m and energy E is given by Einstein's mass-energy equation.

$E = mc^2$

Here c is the speed of light (3×10^8 ms^{-1}. The above equation shows that tremendous amount of energy can be obtained from small quantity of matter.

Question: What is meant by the efficiency of a system? OR How can you find the efficiency of a system?

The ratio of the useful work done by a device or machine to the total energy taken up by it is called its efficiency.

$$\text{Efficiency} = \frac{\text{Required form of output}}{\text{Total input energy}}$$

$$\%\text{age Efficiency} = \frac{\text{Required form of output}}{\text{Total input energy}} \times 100$$

Ideal system/Ideal machine:

An ideal system is that which gives an output equal to the total energy used by it. In other words, its efficiency is 100%.

People have tried to design a working system that would be 100% efficient. But practically such a system does not exist.

Question: When does a force do work? Explain.

- Work is said to be done when a force acts on a bocy and moves it in the direction of the force.
- Greater is the force acting on a body and longer is the distance moved by it, larger would be the work done.
- Mathematically, Work is a product of force F and displacement S in the direction of force.

Question: Why do we need energy?

The energy is an important and fundamental concept in science. It links almost all the natural phenomena. When we say that a body has energy, we mean that it has the ability to do work. Water running down the stream has the ability to do work, so it possesses energy. The energy of running water be used to run water mills or water turbines.

Question: Which form of energy is most preferred and why?

Solar energy is the energy coming from the Sun and is used directly and indirectly. Sunlight does not pollute the environment in any way. The sunrays are the ultimate source of life on the Earth. We are dependent on the Sun for all our food and fuels. If we find a suitable method to use a fraction of the solar energy reaching the Earth, then it would be enough to fulfil our energy requirement.

Question: How is energy converted from one form to another? Explain.
Energy cannot be created nor destroyed, but it can be converted from one form to another.

Examples:

- Rub your hands together quickly. You will feel them warm. You have used your muscular energy in rubbing hands as a result heat is produced. In the process of rubbing hands, mechanical energy is converted into heat energy.
- Processes in nature are the results of energy changes. For example, some of the heat energy from the Sun is taken up by water in the oceans. This increases the thermal energy.

Note:
During the inter-conversion of energy from one form to other forms, the total energy at any time remains constant.

Question: Name the five devices that convert electrical energy into mechanical energy.

- Electric motor converts electrical energy to mechanical energy.
- Drill machine
- Electric fan
- Electric spinner
- Electric grinder

Question: Name a device that converts mechanical energy into electrical energy.
Electric generator converts mechanical energy into electrical energy.

Question: What is meant by the term power?
Power is defined as the rate of doing work.
Mathematically,

Power = P = Work done / Time Taken
P = w/t

Since work is a scalar quantity, therefore, power is also a scalar quantity.

Question: Define watt.
SI unit of power is watt (W). It is defined as:
The power of a body is one watt if it does work at the rate of 1 joule per second.

LONG QUESTIONS

Question: Define K.E. and derive its relation.

The energy possessed by a body due to its motion is called kinetic energy.

Derivation of K.E:

Consider a body of mass of body moving with velocity v. The body stops after moving through some distance S due to some opposing force such as force of friction acting on it. The body possesses kinetic energy and is capable to do work against opposing force F until all of its kinetic energy is used up.

K.E. of the body = Work done by it due to motion
K.E = FS
Vi = v
Vf = 0
F = ma
a = - F/m

Since motion is opposed, hence, a is negative. Using 3rd equation of motion:

$2aS = Vf^2 - Vi^2$
$2 (- F/m) S = (0)^2 - (v)^2$
$-2FS/m = -V^2$
$FS = ½ mv^2$

Question: Define potential energy and derive its relation.

The energy possessed by a body due to its position is known as its potential energy.

Derivation of P.E:

Let a body of mass m be raised up through height h from the ground. The body will acquire potential energy equal to the work done in lifting it to height h.

Thus Potential energy P.E = F x h
= w x h

(Here weight of the body = w = mg)

P.E. = wh = mgh

Thus, the potential energy possessed by the body with respect to the ground is mgh and is equal to the work done in lifting it to height h.

Question: Why fossils fuels are called non-renewable form of energy?

- Fossil fuels are known as nonrenewable resources because it took millions of years for them to attain the present form.
- We use fossil fuels such as coal, oil and gas to heat our houses and run industry and transport.
- They are usually hydrocarbons (compounds of carbon and hydrogen).
- When they are burnt, they combine with oxygen from the air.
- The carbon becomes carbon dioxide; hydrogen becomes hydrogen oxide called water; while energy is released as heat.
- In case of coal:
  Carbon + Oxygen ---------> carbon dioxide + heat energy
  Hydrocarbon + Oxygen -------> carbon dioxide + water + heat energy

PHYSICS FOR 9TH CLASS (UNIT # 6)

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Describe the process of electricity generated by geothermal energy?

- In some parts of the world, the Earth provides us hot water from geysers and hot springs.
- There is hot molten part, deep in the Earth called magma.
- Water reaching close to the magma changes to steam due to the high temperature of magma.
- This energy is called geothermal energy.
- Geothermal well can be built by drilling deep near hot-rocks at places, where magma is not very deep.
- Water is then pushed down into the well.
- The rocks quickly heat the water and change it into steam.
- It expands and moves up to the surface.
- The steam can be piped directly into houses and offices for heating purposes or it can be used to generate electricity.

Question: Describe the process of electricity generated by biomass?

- Biomass is plant or animal wastes that can be burnt as fuel.
- Other forms of biomass are garbage, farm wastes, sugarcane and other plants.
- These wastes are used to run power plants. Many industries that use forest products get half of their electricity by burning bark and other wood wastes.
- Biomass can serve as another energy source, but problems are there in its use.
- When animal dung, dead plants and dead animals decompose, they give off a mixture of methane and carbon dioxide.
- Electricity can be generated by burning methane.

Question: Describe the process of electricity generated by solar cells?

- Solar energy can also be converted directly into electricity by solar cells.
- A solar cell also called photo cell is made from silicon wafer.
- When sunlight falls on a solar cell, it converts the light directly into electrical energy.
- Solar cells are used in calculators, watches and toys. Large numbers of solar cells are wired together to form solar panels.
- Solar panels can provide power to telephone booths, light houses and scientific research centers.
- Solar panels are also used to power satellites.

Question: Describe the process of electricity generated by wind energy?

- Wind has been used as a source of energy for centuries.
- It has powered sailing ships across the oceans.
- It has been used by windmills to grind grain and. pump water.
- More recently, wind power is used to turn wind turbines.
- When many wind machines are grouped together on wind farms, they can generate enough power to operate a power plant.

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PHYSICS FOR 9TH CLASS (UNIT # 7)

SHORT QUESTIONS

Question: Describe briefly about matter?

- Matter exists in three states, solid, liquid and gas.
- There are many properties associated with matter. For example, matter has weight and occupies space.

Question: Is an iron object heavier than that of wood? OR Why is 1em cubed of wood lighter than 1em cubed of iron?

Because centimeters cube is a unit of volume, not weight. The two might take up the same amount of space, but iron is much denser and as such weighs more:

D = m/v

Question: How soap bubbles are produced. Why the soap bubbles so formed have spherical shapes?

- A soap bubble is a very thin sheet of water sandwichec between two layers of soap molecule.
- The film of soapy water surrounds a bubble of air.
- Soap molecules have one end that repels water, and one that attracts it, and these molecules move to the inner and outer surfaces, thrusting their water-repelling ends out into the air, and their "heads" inwards.
- Without such molecules the surface, the bubble would spontaneously break apart into tiny water droplets.

Question: Write about the factors affecting pressure?

i) the size of the force- the greater the force the greater the pressure.
ii) the area of contact - the smaller the area the greater the pressure.

Question: Why does the atmospheric pressure vary with height?

- The atmospheric pressure decreases as we go up. The atmospheric pressure on mountains is lower than at sea level.
- It would become zero at an altitude where there is no air. Thus, we can determine the altitude of a place by knowing the atmospheric pressure at that place.

Question: What is Hydrometer?

Hydrometer is a glass tube with a scale marked on its stem and heavy weight in the bottom. It is partially immersed in a fluid, the density of which is to be measured. One type of hydrometer is used to measure the concentration of acid in a battery. It is called acid meter.

Question: Explain how a wooden block, ships and boats moves up the water surface.

A wooden block floats on water. It is because the weight of an equal volume of water is greater than the weight of the block. According to the principle of floatation, a body

floats if it displaces water equal to the weight of the body when it is partially or completely immersed in water.
Ships and boats are designed on the same principle of floatation. They carry passengers and goods over water. It would sink in water if its weight including the weight of its passengers and goods becomes greater than the up thrust of water.

Question: What is meant by deforming force?
We know that the length of a rubber band increases on stretching it. Similarly, the pointer of a spring balance is lowered when a body is suspended from it. It is because the length of the spring inside the balance increases depending upon the weight of the suspended body.
The applied force that changes shape, length or volume of a substance is called deforming force. In most of the cases, the body returns to its original size and shape as soon as the deforming force is removed.

Question: What is meant by elasticity?
The property of a body to restore its original size and shape as the deforming force ceases to act is called elasticity. Due to elasticity we can determine the strength of a material and the deformation produce under the action of a force. Due to elasticity we can determine the strength of a material and the deformation produce under the action of a force.

Question: Differentiate between stress and strain?
Stress:
The force acting on unit area at the surface of a body is called stress. Thus

Stress = Force / Area

In SI, the unit of stress is newton per square metre (Nm^{-2})
Strain:
A comparison of such a change caused by the stress with the original length, volume or shape is called as strain. If stress produces a change in the length of an object then the strain is called tensile strain.

Tensile strain = change in length / original length

Strain has no units as it is simply a ratio between two similar quantities.

Question: What do you know about Young's modulus? How would you determine young's modulus of an object?
The ratio of stress to tensile strain is called Young's modulus.
Determination of young's modulus:
Consider a long bar of length L_o and cross-sectional area A. Let an external force F equal to the weight w stretches it such that the stretched length becomes L According to Hooke's law, the ratio of this stress to tensile strain is constant within the elastic limit of the body.

Young's modulus Y = Stress / Tensile strain

Question: Does there exist a fourth state of matter? What is that?
Yes, fourth state of matter is called plasma.

Plasma:
At very high temperature, the collision between atoms and molecules tears off their electrons. Atoms become positive ions. This ionic state of matter is called plasma-the fourth state of matter.

Question: What is meant by density? What is its SI unit?
Density of a substance is defined as its mass per unit volume.

Unit of Density:
SI unit of density is kilogramme per cubic metre (kgm^{-3}).

Question: Can we use a hydrometer to measure the density of milk?
Lactometer is used to measure the density of milk. Whereas hydrometer is used to measure the concentration of acid in a battery. It is called acid meter.

Question: Define the term pressure.
The force acting normally per unit area on the surface of a body is called pressure.
Thus Pressure P = Force / Area = F/A
Pressure is a scalar quantity.

Unit of pressure:
In SI units, the unit of pressure is Nm^{-2} also called pascal (Pa). Thus
$1Nm^{-2}$ = 1Pa

Question: Show that atmosphere exerts pressure.
The Earth is surrounded by a cover of air called atmosphere. It extends to a few hundred kilometers above sea level. Just as certain .sea creatures live at the bottom of ocean, we live at the bottom of a huge ocean of air. Air is a mixture of gases. The density of air in the atmosphere is not uniform, it decreases continuously as we go up. Atmospheric pressure acts in all directions.

Question: It is easy to remove air from a balloon but it is very difficult to remove air from a glass bottle. Why?
This is because the air inside the balloon is at a fairly high pressure than the atmosphere pressure air outside the balloon. On the other hand air pressure inside the glass bottle is already equal to the atmospheric pressure so it is difficult to remove air from a glass bottle.

Question: Why water is not suitable to be used in a barometer?
Mercury is 13.6 times denser than water. Atmospheric pressure can hold vertical column of water about 13.6 times the height of mercury column at a place.
Thus. at sea level, vertical height of water column would be 0.76 m x 13.6 = 10.34 m. Thus, a glass tube more than 10m long is required to make a water barometer. Therefore water is not suitable tc be used in a barometer

Question: What does It mean when the atmospheric pressure at a place fall suddenly?

The changes in atmospheric pressure at a certain place indicate the expected changes in the weather conditions of that place. For example, a gradual and average drop in atmospheric pressure means a low pressure in a neighboring ocality. Minor but rapid fall in atmospheric pressure indicates a windy and showery cond1tion in the nearby region. A decrease in atmospheric pressure is accompanied by breeze and rain. Where as a sudden fall in atmospheric pressure often followed by a storm, rain and typhoon to occur in few hours time.

Question: What Changes are expected in weather if the barometer reading shows a sudden increase?

On the other hand, an increasing atmospheric pressure with a decline later on predicts an intense weather conditions. A gradual large increase in the atmospheric pressure indicates a long spell of pleasant weather A rapid increase in atmospheric pressure means that it will soon be followed by a decrease in the atmospheric pressure indicating poor weather ahead.

Question: State Pascal's law.

Pressure applied at any point of a liquid enclosed in a container, is transmitted without loss to all other parts of the liquid.

Applications of pascal's law:

Pascal's law finds numerous applications in our daily life such as automobiles, hydraulic brake system, hydraulic jack, hydraulic press and other hydraulic machine.

Question: What is meant by elasticity?

The property of a body to restore its original size and shape as the deforming force ceases to act is called elast city.

Due to elasticity we can determine the strength of a material and the deformation produce under the action of a force.

Question: Explain how a submarine moves up the water surface and down into water?

A submarine can travel over a swell as under water. It also works on the principle of floatation. It floats over water when the weight of water equal to its volume is greater than its weight. Under this condition, it is similar to a ship and remains partially above water level. It has a system of tanks which can be filled with and emptied from seawater. When these tanks are filled with seawater, the weight of the submarine increases. As soon as its weight becomes greater than the upthrust, it dives into water and remains under water. To come up on the surface, the tanks are emptied from seawater.

Question: Why does a piece of stone sink in water but a ship with a huge weight floats?

It is due to Archimedes principle. Density of ship is less it displace more liquid, experience more upward thrust and floats where as density of stone is more, it displace less liquid experience less upward thrust and sinks.

Question: What is Hooke's law? What is meant by elastic limit?

The strain produced in a body by the stress applied to it is directly proportional to the stress within the elastic limit of the body. Thus

stress α strain

The greatest stress that can be applied to a material without causing permanent deformation is called elastic limit.

The stress point at which a material, if subjected to higher stress, will no longer return to its original shape. Brittle materials tend to break at or shortly past their elastic limit, while ductile materials deform at stress levels beyond their elastic limit.

Question: Take a rubber band. Construct a balance of your own using a rubber band. Check its accuracy by weighing various objects.

We know that the length of a rubber band increases on stretching it. Similarly, the pointer of a spring balance is lowered when a body is suspended from it. It is because the length of the spring inside the balance increases depending upon the weight of the suspended body.

A rubber band scale will be fairly accurate but only for a short tune. Eventually the rubber band will begin to stretch and wear out. A better scale may be made by substituting a metal spring for the rubber band. Such a scale will be just as accurate, and because the spring is made of rnetal, it will last much longer.

Question: Explain the breaking system in vehicles?

The braking systems of cars, buses, etc. also work on Pascal's law. The hydraulic brakes allow equal pressure to be transmitted throughout the liquid. When brake pedal is pushed, it exerts a force on the master cylinder, which increases the liquid pressure in it. The liquid pressure is transmitted equally through the liquid in the metal pipes to all the pistons of other cylinders. Due to the increase in liquid pressure, the pistons in the cylinders move outward pressing the brake pads with the brake drums. The force of friction between the brake pads and the brake drums stops the wheels.

Question: State Archimedes principle.

When an object is totally or partially immersed in a liquid an up thrust acts on it equal to the weight of the liquid it displaces.

Explanation: -

***Draw figure here

i) Let a graduated cylinder was filled with water.
ii) A cylindrical solid object of volume 'V' having length 'l' and area of cross section 'a' was immersed in graduated cylinder through a depth 'X'
iii) The length of lower part of this body to upper surface of liquid is X + l.

Pressure of liquid column depends on its: -

i) Height or depth
ii) Density of water (ρ)
iii) Gravitational acceleration

$P_1 = \rho g x$

And

$P_2 = \rho g(X+l)$

Difference in pressure $= P_2 - P_1 = \rho g(X+1-X)$

$= \rho gl$

Due to this pressure difference, there acts a force in the upward directions from lower surfaces is

$F = (P_2 - P_2)\ a$

$= \rho gla$

Lergth of solid body is 'l' and area is 'a' then volume will be 'la'. Since

Mass of liquid equal to volume of solid body = volume x density

$m = la \times \rho$

$= \rho la$

We know that

$F = mg$

By putting the value of m

$F = \rho lag$

Where mg is the weight of liquid displaced by the volume of solid. So it is clear here that: -

When an object is immersed in a liquid, the liquid exerts a up thrust force on the object, which is equal to the weight of the liquid displaced by the object. This force is called **up-thrust force** or **buoyancy**.

If weight of a body is greater than this up-thrust force, body will sink in liquid. But if up-thrust force is greater than weight of body, then body will float over water surface.

Question: Explain the working of hydraulic press.

Hydraulic press is a machine which works on Pascal's law. It consists of two cylinders of different cross-sectional areas. They are fitted with pistons of cross- sectional areas a and A.

The object to be compressed is placed over the piston of large cross sectional area A. The force F1 is applied on the piston of small cross-sectional area a. The pressure P produced by small piston is transmitted equally to the large piston and a force F2 acts on A which is much larger than F1.

Pressure on piston of small area a is given by

$P = F1/a$

Apply Pascal's law, the pressure on large piston of area A will be the same as on small piston.

$P = F2/a$

Comparing the above equations, we get

F2/a = F1/a

F2 = A x F1/a

F2 = F1 x A/a

Question: How kinetic molecular model of matter is helpful in differentiating various states of matter?

(i) Matter is made up of particles called molecules.
(ii) The molecules remain in continuous motion.
(iii) Molecules attract each other.

Characteristics of Kinetic Molecular Model of Matter:

Kinetic molecular model is used to explain the three states of matter- solid, liquid and gas.

Solids:

- Solids such as a stone, metal spoon, pencil, etc. have fixed shapes and volume.
- Molecules of solids are helc close together by strong forces of attraction.
- Molecules of solids vibrate about their mean positions but do not move from place to place.

Liquids:

- The distances between the molecules of a liquid are more than in solids. Thus, attractive forces between them are weaker.
- Like solids, molecules of a liquid also vibrate about their mean posit1on but are not rigidly held with each other.
- Due to the weaker attractive forces, they can slide over one another. Thus, the liquids can flow.
- The volume of a certain amount of liquid remains the same but because it can flow hence, it attains the shape of a container to which it is put.

Gases:

- Gases such as air have no fixed shape or volume. They can be filled in any container of any shape.
- Their molecules have random motion and move with very high velocities. In gases, molecules are much farther apart than solids or iquids. Thus, gases are much lighter than solids and liquids.
- They can be squeezed into smaller volumes.
- The molecules of a gas are constantly striking the walls of a container. Thus, a gas exerts pressure on the walls of the container. (P α K.E)

Plasma - The fourth state of matter:

- Atoms lose their electrons and become positive ions. This ionic state of matter is called plasma. Plasma is also formed in gas discharge tubes when electric current passes through these tubes.
- Plasma is ca led the fourth state of matter in which a gas occurs in its ionic state. Positive ions and electrons get separated in the presence of electric or magnetic fields.

- Plasma also exists in neon and fluorescent tubes when they glow.
- Most of the matter that fills the universe is in plasma state.
- In stars such as our Sun, gases exist in their Ionic state.
- Plasma is highly conducting state of matter. It allows electric current to pass through it.

Question: What is upthrust? Explain the principle of floatation.

Upthrust is the force that pushes an object up and makes it seem to lose weight in a fluid. (Remember, a fluid means a liquid or a gas).

The upthrust, or buoyancy, keeps ships afloat. The upthrust, or buoyancy, keeps swimmers on top of the water.

Principle of floatation:

An object sinks if its weight is greater than the upthrust acting on it. An object floats if its weight is equal or less than the upthrust. When an object floats in a fluid, the upthrust acting on it is equal to the weight of the object.

In case of floating object, the object may be partially 1mmersed. The upthrust is always equal to the weight of the fluid displaced by the object. This is the principle of floatation It states that:

A floating object displaces a fluid having weight equal to the weight of the object. This law is applicable on liquids as well as gases.

Question: What is a barometer?

At sea level, the atmospheric pressure is about 101,300 Pa or 101.300 Nm^{-2}.

Barometer:

The instruments that measure atmospheric pressure are called barometers. One of the simple barometers is a mercury barometer. It consists of a glass tube 1 metre long closed at one end.

Construction:

After filling it with mercury, it is inverted in a mercury trough. Mercury in the tube descends and stops at a certain height. The column of mercury held in the tube exerts pressure at its base. At sea level the height of mercury column above the mercury in the trough is found to be about 76 em. Pressure exerted by 76 em of mercury column is nearly 101,300 Nm^{-2} equal to atmospheric pressure. It is common to express atmospheric pressure in terms of the height of mercury column. As the atmospheric pressure at a place does not remains constant, hence, the height of mercury column also varies with atmospheric pressure.

Define the terms heat and temperature.

Heat:

Heat is the energy that is transferred from one body to the cther in thermal contact with each other as a result of the difference of temperature between them.

Temperature:

Temperature of a body is the degree of hotness or coldness of the body.

Define the terms thermal conduct and thermal equilibrium.

Thermal Conduct:

In heat transfer and thermodynamics, a thermodynamic system is said to be in thermal contact with another system if it can exchange energy with it through the process of heat.

Thermal Equilibrium:

When two objects A and B are in thermal contact and there is no net transfer of thermal energy from A to B or from B to A, they are said to be in thermal equilibrium.

Define the terms energy in transit and internal energy.

Energy in transit:

The form of energy that is transferred from a hot body to a cold body is called heat. Thus Heat is therefore called as the energy in transit.

Internal energy:

The sum of kinetic energy and potential energy associated with the atoms, molecules and particles of a body is called its internal energy.

Describe the feature of liquid-in-glass thermometer OR Describe the feature of mercury-in-glass thermometer?

Liquid-in-glass thermometer:

A liquid in glass thermometer has a bulb with a long capillary tube of uniform and fine bore. A suitable liquid is filled in the bulb. When the bulb contacts a hot object, the liquid in it expands and rises in the tube. The glass stem of a thermometer is thick and acts as a cylindrical lens. This makes it easy to see the liquid level in the glass tube.

Uses:

Thus mercury is one of the most suitable thermometric materials. Mercury-in-glass thermometers are widely used in laboratories, climes and houses to measure temperatures in the range from -10°C to 150°C.

What do you mean by lower and upper fixed points in thermometer?

- A thermometer has scale on its stem. This scale has two fixed points. The lower fixed point is marked to show the position of liquid in the thermometer when it is placed in ice.
- Similarly upper fixed poirt is marked to show the position of liquid in the thermometer when it is placed in steam at standard pressure above boiling water.

Describe the importance of large specific heat capacity of water.

Water has a large specific heat capacity. For this reason, it is very useful in storing and carrying thermal energy due to its high specific heat capacity. The cooling system of automobiles uses water to carry away unwanted thermal energy. In an automobile, large amount of heat is produced by its engine due to which its temperature goes on increasing. The engine would cease unless it is not cooled down. Water circulating around the engine by arrows in maintains its temperature. Water absorbs unwanted thermal energy of the engine and dissipates heat through its radiator.

Define heat capacity.

Heat capacity of a body is the quantity of thermal energy absorbed by it for one kelvin (1 K) increase in its temperature.

Define fusion point and freezing point?

When a substance is changed from solid to liquid state by adding heat, the progress is called melting or fusion. The temperature at which a solid starts melting is called its fusion point or melting point.

Freezing point:

The temperature at which a substance changes from liquid to solid state is called its freezing point. However, the freezing point of a substance is the same as its melting point.

Define thermal expansion.

Thermal expansion is the tendency of matter to change in volume in response to a change in temperature.

Derive the relation for linear thermal expansion in solids. OR
Show that L = Lo (1+ α Δ T)

Consider a metal rod of length Lo at certain temperature To. Let its length on heating to a temperature T becomes L Thus

Increase in length of the rod = $\Delta L = L - L_o$

Increase in temperature = $\Delta T = T - T_o$

It is found that change in length ΔL of a solid is directly proportional to its original length Lo , and the change in temperature ΔT. That is;

$\Delta L \propto L_o \Delta T$

Or $\Delta L = \alpha L_o \Delta T$ ..... (i)

Or $L - L_o = \alpha L_o \Delta T$

Or $L = L_o + \alpha L_o \Delta T$

Or $L = L_o (1 + \alpha \Delta T)$ ..... (ii)

Where α is called the coefficient of linear thermal expansion of the substance.

From equation (i), we get

$\alpha = \Delta L / L_o \Delta T$

Coefficient of linear expansion (α):

We can define the coefficient of linear expansion a of a substance as the fractional increase in its length per kelvin rise in temperature.

Why gaps are left m railway tracks?
Gapes are left in railway tracks to compensates thermal expansion during hot season. Railway tracks buckled on a hot summer day due to expansion if gaps are not left between sections.

Why gaps are left in bridges with rollers?
Bridges made of steel girders also expand during the day and contract during night. They will bend if their ends are fixed. To allow thermal expansion, one end is, fixed while the other end of the girder rests on rollers in the gap left for expansion.

Why overhead transmission lines (wires on electric poles) are also given a certain amount of sag?
Overhead transmission lines are also given a certain amount of sag so that they can contract in winter without snapping.

List the application of thermal expansion?
i. In thermometers, thermal expansion is used in temperature measurements.
ii. To open the cap of a bottle that is tight enough, immerse it in hot water for a minute or so. Metal cap expands and becomes loose. It would now be easy to turn it to open.
iii. To join steel plates tightly together, red hot rivets are forced through holes in the plates. The end of hot rivet is then hammered. On cooling, the rivets contract and bring the plates tightly gripped.
iv. Iron rims are fixed on wooden wheels of carts. Iron rims are heated. Thermal expansion allows them to slip over the wooden wheel. Water is poured on it to cool. The rim contracts and becomes tight over the wheel.

Explain that the bi-metallic strip used in thermostat is based on different rate of expansion of different metals on heating.
A bimetal strip consists of two thin strips of different metals such as brass and iron joined together. On heating the strip, brass expands more than iron. This unequal expansion causes bending of the strip.

Uses of bimetal strips:
- Bimetal thermometers are used to measure temperatures especially in furnaces and ovens.
- Bimetal strips are also used in thermostats.
- Bimetal thermostat switch such is used to control the temperature of heater coil in an electric iron.

What is Anomalous expansion of water?
Water on cooling below 4°C begins to expand until it reaches 0°C. On further cooling its volume increases suddenly as it changes into ice at 0°C. When ice is cooled below 0°C, it contracts i.e. its volume decreases like solids. This unusual expansion of water is called the anomalous expansion of water.

Why the coefficient of volume expansion of liquids is greater than solids?
The molecules of liquids are free to move in all directions within the liquid. On heating a liquid, the average amplitude of Vibration of its molecules Increases. The molecules push each other and need more space to occupy. This accounts for the expansion of the liquid when heated. The thermal expansion in liquids is greater than solids due to the weak forces between their molecules. Therefore, the coefficient of volume expansion of liquids is greater than solids.

Explain thermal expansion of liquids OR
Differentiate between real and apparent expansion of liquid? Thermal expansion of liquids:
Liquids also expand on heating. As they do not have any shape, therefore only volume expansion is measured in liquids.
There are two types of expansior of liquids:

i) Real Expansion
ii) Apparent Expansion

Real Expansion: -
In figure real expansion is from B to C.
Apparent Expansion: -
When we heat a liquid in a flask. Flask expand and level of water first fall from A to B. then it rises upto C. So expansion from A to C is apparent expansion.
In figure, A to B shows the expansion of flask. Real expansion is greater than apparent expansion.
Real expansion = Apparent Expansion + Expansion of Flask
Co-efficient of Apparent Expansion; -
The apparent increase in volume of one cubic meter of liquid when heated through one - Kelvin temperature is called co-efficient of apparent expansion. It is denoted by (g)
Co-efficient of Real Expansion: -
The real increase in volume of one cubic meter of liquid when heated through one-Kelvin temperature is called co-efficient of apparent expansion. It is denoted by (r)

EXERCISES

Why does heat flow from hot body to cold body?
Heat flows from warm to cold because the energy state is higher.

How does heating affect the motion of molecules of a gas?
The larger the temperature of a gas the faster the molecules will move (temperature is proportional to the average kinetic energy of the particles) and the larger the force they will exert, and the higher the pressure (pressure is the force exerted by the particles divided by the area).

What is a thermometer? Why mercury is preferred as a thermometric substance?

A device that is used to measure the temperature of a body is called thermometer.

Principle of thermometer:

Mercury thermometers are based on the fact that materials (in this case, the liquid mercury) expand when heated.

Basic properties of thermometric liquid:

A thermometric liquid should have the following properties:

- It should be visible.
- It should have uniform thermal expansion.
- It should have a low freezing point.
- It should have high boiling point.
- It should not wet glass.
- It should be a good conductor of heat.
- It should have a small specific heat capacity.

Preference of mercury:

Mercury has uniform thermal expansion, easily visible, has low freezing point, and has high boiling point and less specific heat.

Explain the volumetric thermal expansion.

The volume of a solid also changes with the change in temperature and is called volume thermal expansion or cubical thermal expansion.

Consider a solid of initial volume Vo at certain temperature To . On heating the solid to a temperature T, let its volume becomes V , then

Change in the volume of a solid $\Delta V = V - Vo$

And

Change in temperature $\Delta T = T - To$

Like linear expansion, the change in volume ΔV is found to be proportional to its. original volume Vo and change in temperature ΔT. Thus

$\Delta V \propto Vo\,\Delta T$

Or $\Delta V = \alpha\, Vo\,\Delta T$ ..... (i)

Or $V - Vo = \alpha\, Vo\,\Delta T$

Or $V = Vo + \alpha\, Vo\,\Delta T$

Or $V = Vo\,(1 + \alpha\,\Delta T)$ ..... (ii)

Where α is called the coefficient of linear thermal expansion of the substance.

From equation (i), we get

$\alpha = \Delta V / Vo\,\Delta T$

Coefficient of volume expansion (B):

Thus, we can define the temperature coefficient of volume expansion as the fractional change in its volume per kelvin change in temperature. The coefficients of linear expansion and volume expansion are related by the equation:

$B = 3\alpha$

Define specific heat. How would you find the specific heat of a solid?
Specific heat of a substance is the amount of heat required to raise the temperature of 1 kg mass of that substance through 1K.
It has been observed that the quantity of heat ΔQ required to raise the temperature ΔT of a body is proportional to the mass m of the body. Thus

$\Delta Q \quad \alpha \quad m \Delta T$

or

$\Delta Q \quad = \quad c\, m \Delta T$

Here ΔQ is the amount of heat absorbed by the body and c is the constant of proportionality called the specific heat capacity or simply specific heat.
Mathematically,

$c \quad = \quad \Delta Q/m\Delta T$

Unit of specific heat:
SI unit of specific heat is $Jkg^{-1}K^{-1}$

Define and explain latent heat of fusion.
Heat energy required to change unit mass of a substance from solid to liquid state at its melting point without change in its temperature is called its latent heat of fusion. It is denoted by H_f.

Define latent heat of vaporization.
The quantity of heat that changes unit mass of a liquid completely into gas at its boiling point without any change in its temperature is called its latent heat of vaporization. It is denoted by H_v.

What is meant by evaporation? On what factors the evaporation of liquid depends?
Evaporation is the changing of a liquid into vapours (gaseous state) from the surface of the liquid without heating it.

Evaporation causes cooling:
Evaporation plays an important role in our daily life. Wet clothes dry up rapidly when spread. During evaporation; fast moving molecules escape out from the surface of the liquid. Molecules that have lower kinetic energies are left behind. This lowers the average kinetic energy of the liquid molecules and the temperature of the liquid. Since temperature of a substance depends on the average kinetic energy of its molecules. Evaporation of perspiration helps to cool our bodies.
T α K. E

Evaporation takes place at all temperature from the surface of a liquid. The rate of evaporation is affected by various factors.

Factors affecting the rate of evaporation:

i. Temperature:

Why wet clothes dry up more quickly in summer than in winter? At higher temperature, more molecules of a liquid re moving with high velocities. Thus, more molecules escape from its surface. Thus, evaporation is faster at high temperature than at low temperature.

ii. Surface area:

Why water evaporates faster when spread over large area? Larger is the surface area of a liquid, greater number of molecules has the chance to escape from its surface.

iii. Wind:

Wind blowing over the surface of a liquid sweeps away the liquid molecules that have just escaped out. This increases the chance for more liquid molecules to escape out.

iv. Nature of the liquid:

Does spirit and water evaporate at the same rate? Liquids differ in the rate at which they evaporate. Spread a few drops of ether or spirit on your palm. You feel cold, why?